Land-Use and Transport Integration in Scotland (LATIS)

TMfS:07 Developer's Guide

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Appendices

A - Cube Catalog Keys

1 Introduction

1.1 This Document

1.1.1 The purpose of this Developer's User Manual is to familiarise a model developer with the programming and structure of TMfS:07.

1.1.2 This document provides an overview of the TMfS:07 structure, key components and highlights any unusual scripting or complex procedures. This should assist further development of the transport model in future. It is not intended to be a detailed description of the TMfS:07 application, which is provided in the User Manual (MVA Consultancy, May 2011).

1.1.3 It is assumed that the reader is familiar with both the principles and operation of the Cube software suite and has a sound understanding of a Windows operating system. It is also expected that users have the requisite knowledge of transport and land-use modelling and, in particular, transport model development using Cube and VOYAGER.

2 Model Overview and Report Structure

2.1 Model Overview

2.1.1 The Transport Model for Scotland (TMfS) is built in Cube Voyager software with a CUBE Catalog to control the model application and allow multiple scenarios to be run and stored. The main model consists of the following components

- Pre Run Set-up;
- Demand Model;
  - mode and destination choice;
  - high occupancy vehicle (HOV) modelling;
  - park and ride (P&R) site choice;
  - creation of To-Home and Non-Home based trips; and
  - creation of assignment matrices.
- Highway Assignment;
- Public Transport (PT) Assignment
- Creation of Generalised Costs;
- Trip Frequency Modelling;
- Macro Time of Day Modelling (not fully operational);
- Calculation and outputting of Convergence Stats;
- Post-Run Analysis; and
- File Deletion.

2.1.2 There are two loops in the model as follows:

- The **Inner Loop** which iterates between Mode and Destination choice; and
- The **Outer Loop** which iterates between the Demand Model (including mode and destination choice, HOV modelling, P&R choice) and the Assignment Models (highway and PT).

2.1.3 The Trip Frequency and Macro Time of Day models are optional extras and are run from the Outer Loop only.

2.1.4 Figure 2.1 shows the overall structure of the model as described above and the outer loop – represented by the red circle loop control and looping over the boxed subgroups.

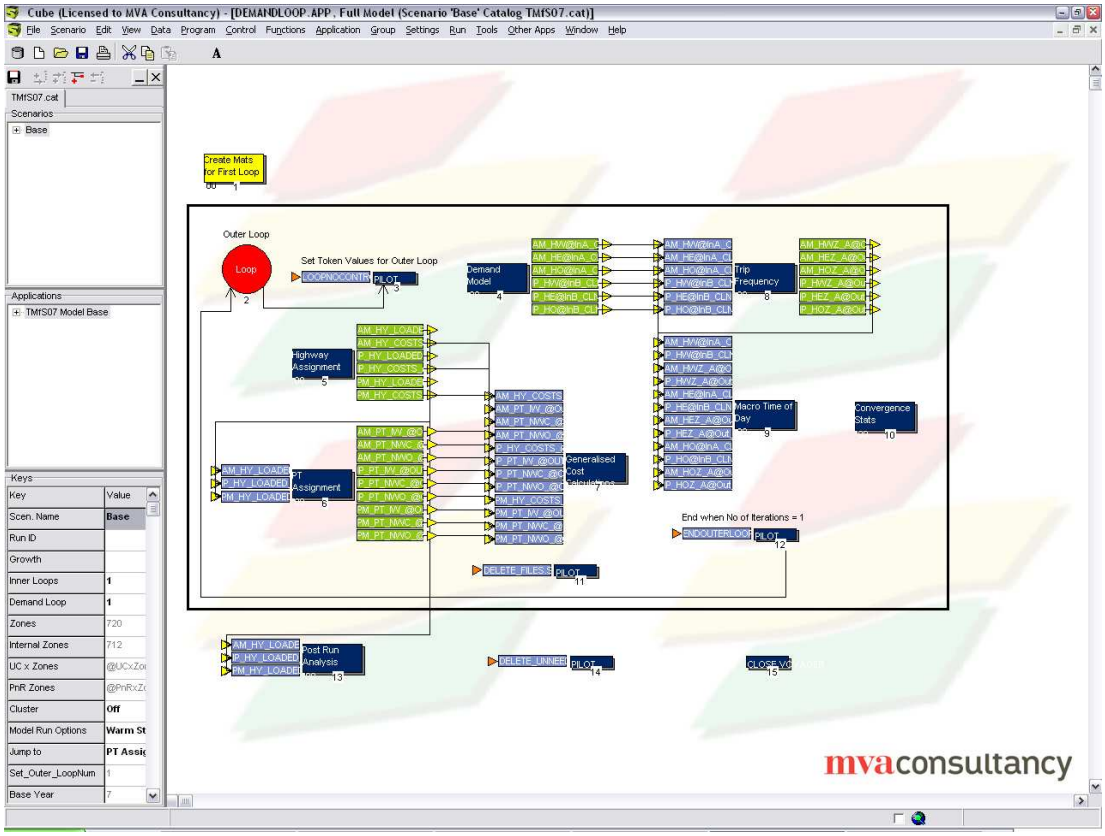

Figure 2.1 – Overall Model Layout

2.2 Catalog Keys

2.2.1 As outlined above, TMfS:07 has been developed in CUBE Voyager software with a Cube Catalog to control the application of the model. This includes the specification of a series of keys that control the model files, parameters and variables. Keys are divided into two categories as follows:

- Model Developer - keys that define the model parameters and typically, should not be amended following model development; and
- Model Applier - keys that control the application of the model and are available to general users, examples include model run details, level of functionality, input files and specification of outputs.

2.2.2 Appendix A lists the TMfS:07 catalog keys and provides a brief description of each.

2.3 Document Structure

2.3.1 The remainder of this document provides a description of each the model components listed in the bullets above, giving details of the processes undertaken.

3 Model Preparation Procedures

3.1 Pre Run Set Up

3.1.1 Before the main model run is started there are a number of steps undertaken to prepare the run. These are.

- creation of output folders;
- setting of no of processors and Cluster controls;
- Setting of number of zones for stacked matrices (see Chapter 4 - Demand Model for more info);
- controls for GOTO points – depending on choice of catalog keys to allow "warm starting" the model from key locations (PILOT programs located at the beginning of each Warm Start point contain the code setting the location for the GOTO commands); and
- average generalised cost matrices for the demand model are created, including calculating intrazonal values and adding parking charges.

3.1.2 TMfS:07 includes a custom-built program called "No of Processors" to determine the number of cores available on the computer. This determines how many processes can be run in parallel using Citilabs Cluster software, up to a maximum of four. There is a related custom-built program called "Close Voyager" which closes the Cluster windows when the model run is complete.

3.1.3 Figure 3.1 shows the PILOT steps which create the output folders and control the GOTO points. The Cluster Set-up subgroup is shown in Figure 3.2 and contains the process that determines the number of cores to use during the model run through the user program "No of Processors". The contents of the remaining subgroup, titled Full Model, are shown in Figure 2.1.

3.1.4 Figure 3.3 shows the process that calculates the average generalised costs for the demand model.

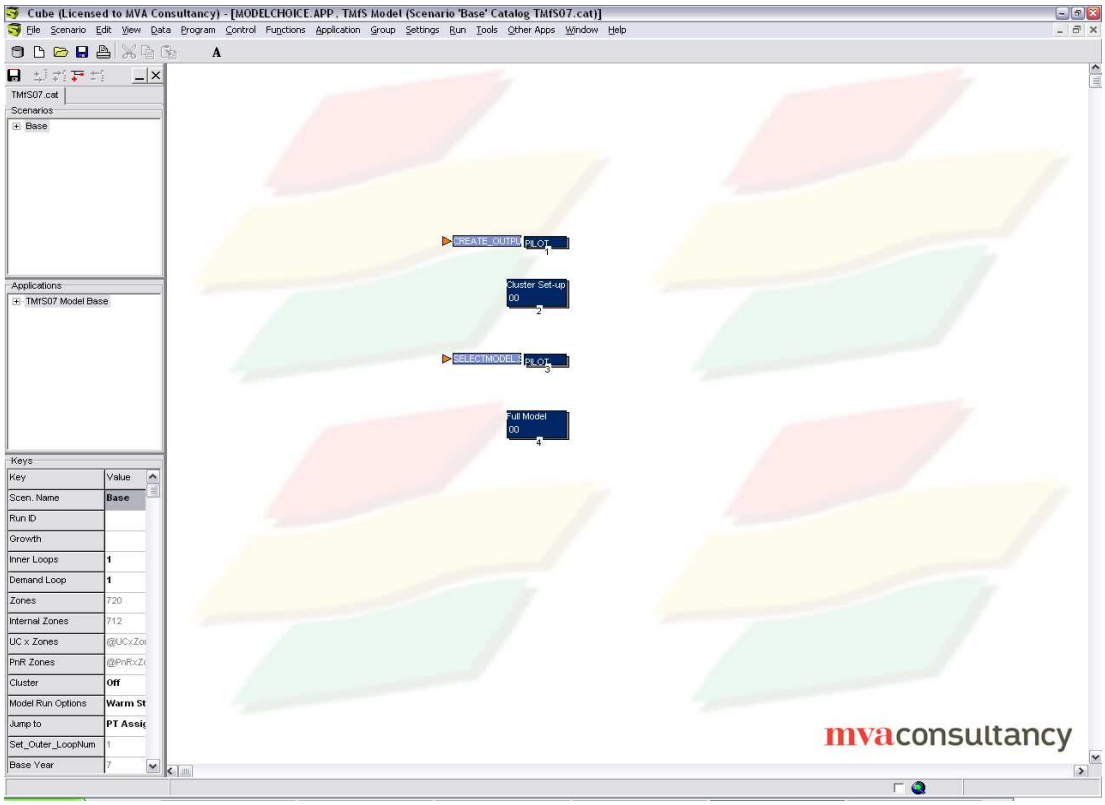

Figure 3.1 – Pre Run Setup Layout 1

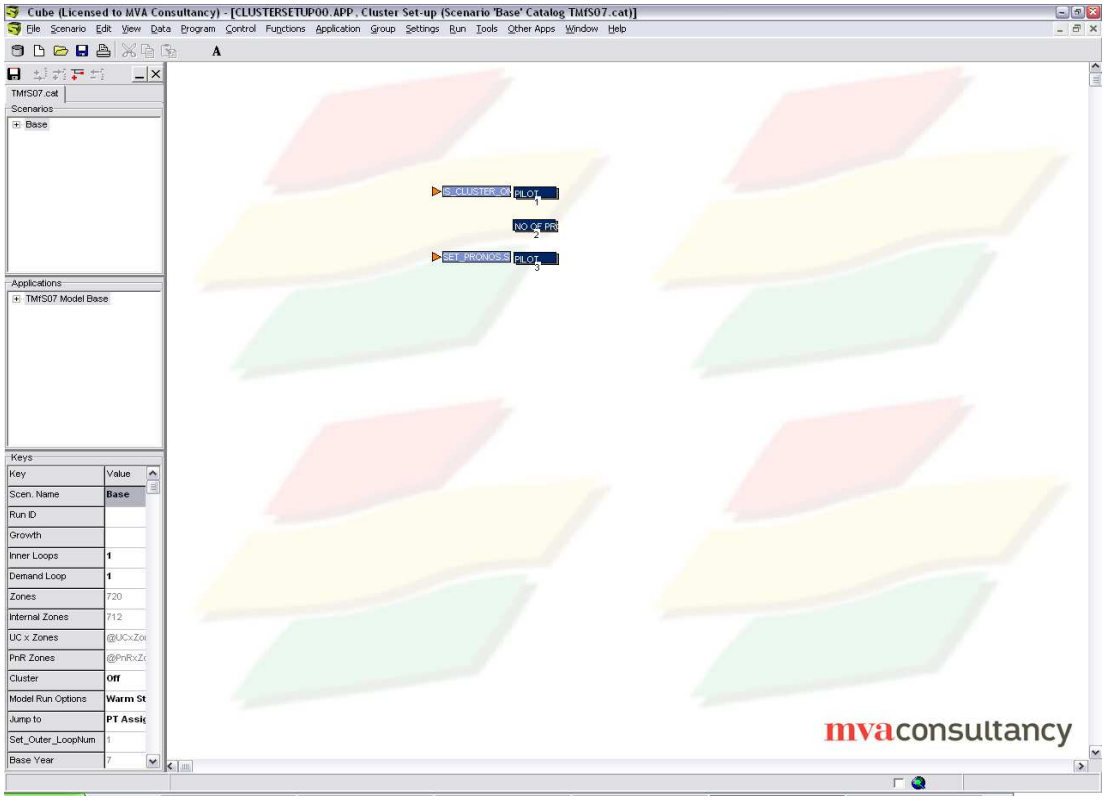

Figure 3.2 – Pre Run Setup Layout 2

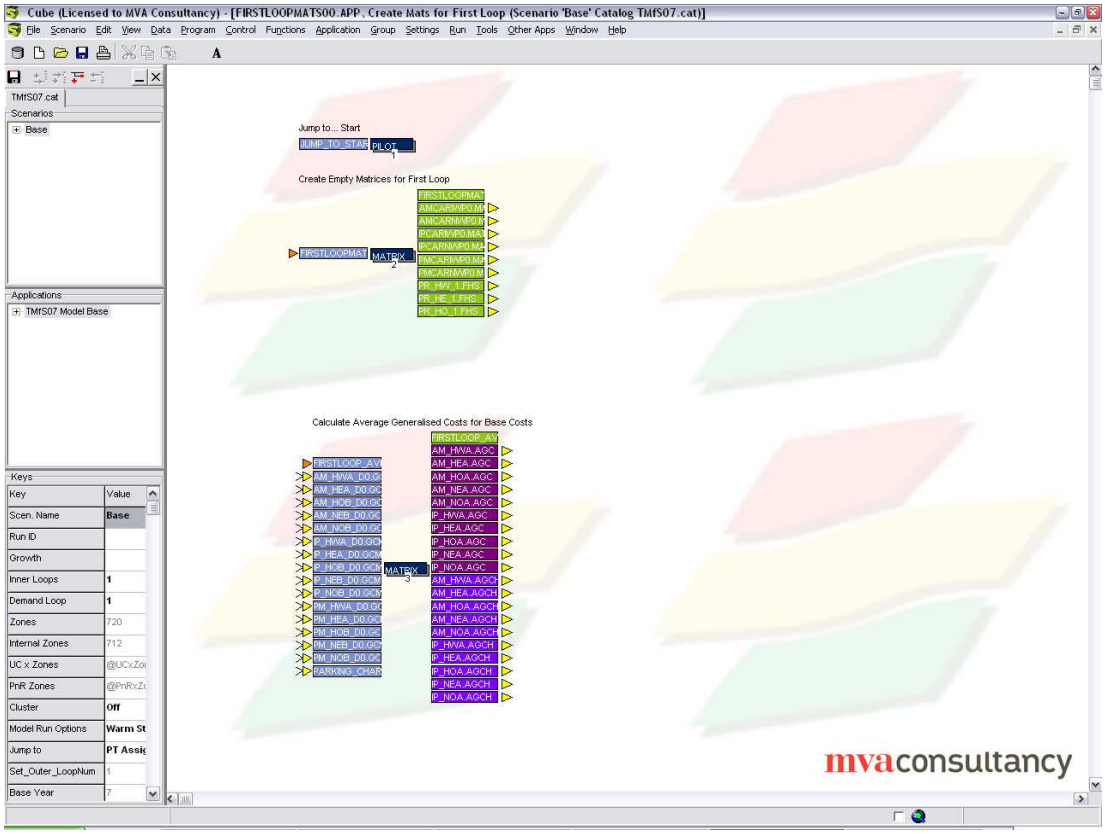

Figure 3.3 – Average Generalised Cost Calculations

4 Demand Model

4.1 Introduction

4.1.1 The demand model is made up of five components, viz:

- Mode and Destination Choice;
- High Occupancy Vehicle Modelling;
- Park & Ride Site Choice;
- Creation of To-Home and Non-Home Based Trips (Reverse Factoring); and
- Creation of Assignment Matrices.

4.1.2 Figure 4.1 below shows the layout of the Demand Model subgroup. The P&R model and Reverse Factoring subgroups are included in a loop control. Although only the P&R model is affected by the looping (see P&R details below), the Reverse Factoring subgroup is included to allow the use of Cluster and parallel processing to reduce model run-times.

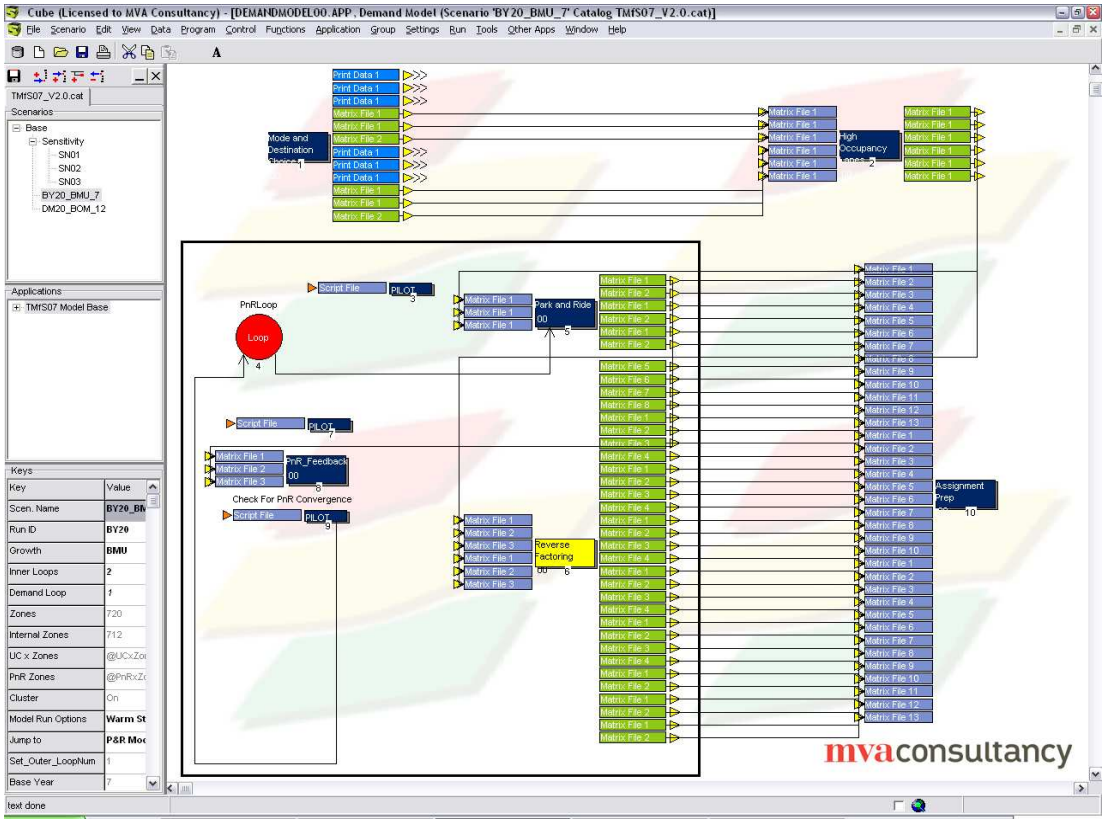

Figure 4.1 – Demand Model Layout

4.2 Mode and Destination Choice

4.2.1 The Mode and Destination Choice model is run for the AM and IP time periods for three purposes (work, employers business and other). Within each purpose there are three modes:

- Car;
- Public Transport (PT); and
- Park & Ride (P&R).

and four car availability classes:

- No Car Available (C0);
- 1 Car Available, 1 Adult Household (C11);
- 1 Car Available, 2+ Adult Household (C12); and
- 2+ Car Available (C2).

4.2.2 This results in 10 car availability and mode pairs (as Non-Car Available people are captive to PT).

4.2.3 Each trip end file contains productions for each of these 10 classes, but only total attractions. The destination choice model works by "stacking" the individual classes into one column of productions and one of attractions. It should be noted that the trip end model does not explicitly include a P&R mode as P&R forecasts are not available in NTEM. It produces trip end files for car and PT where P&R is included in PT. The demand model then derives P&R trip ends for the initial loop using base year proportions that are held in the PRP files applied to the PT trip ends.

4.2.4 For Home-based Work the FRATAR program is used to produce a doubly constrained matrix by furnessing the trip ends to a cost-based deterrence function. Home-based employers business and other are singly constrained, so the trips are simply spread across the columns using the deterrence function.

4.2.5 These matrices are then unstacked into the 10 user classes and used to calculate the composite costs for the mode choice model.

4.2.6 Figure 4.2 shows the layout of the Mode and Destination Choice top level subgroup showing the AM and IP subgroups and the Cluster controls (red boxes). Figure 4.3 shows the AM demand model layout – which also shows the Inner Loop process.

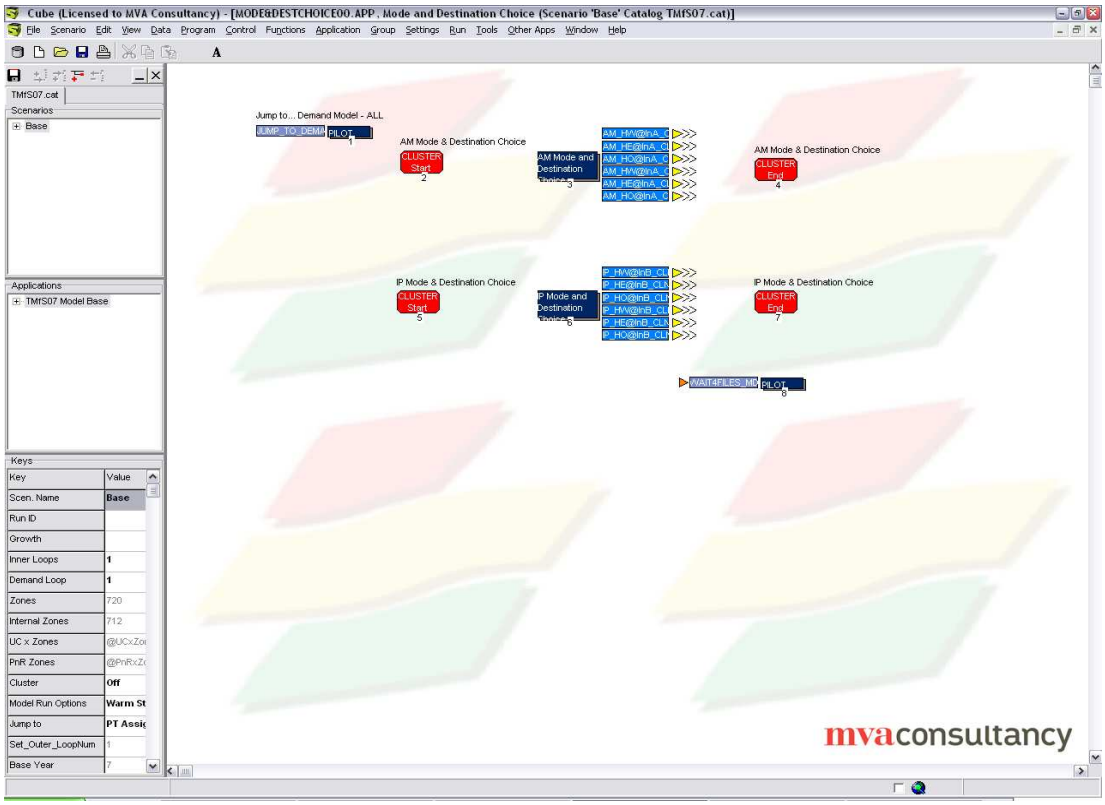

Figure 4.2 – Mode and Destination Choice Layout – Top Level

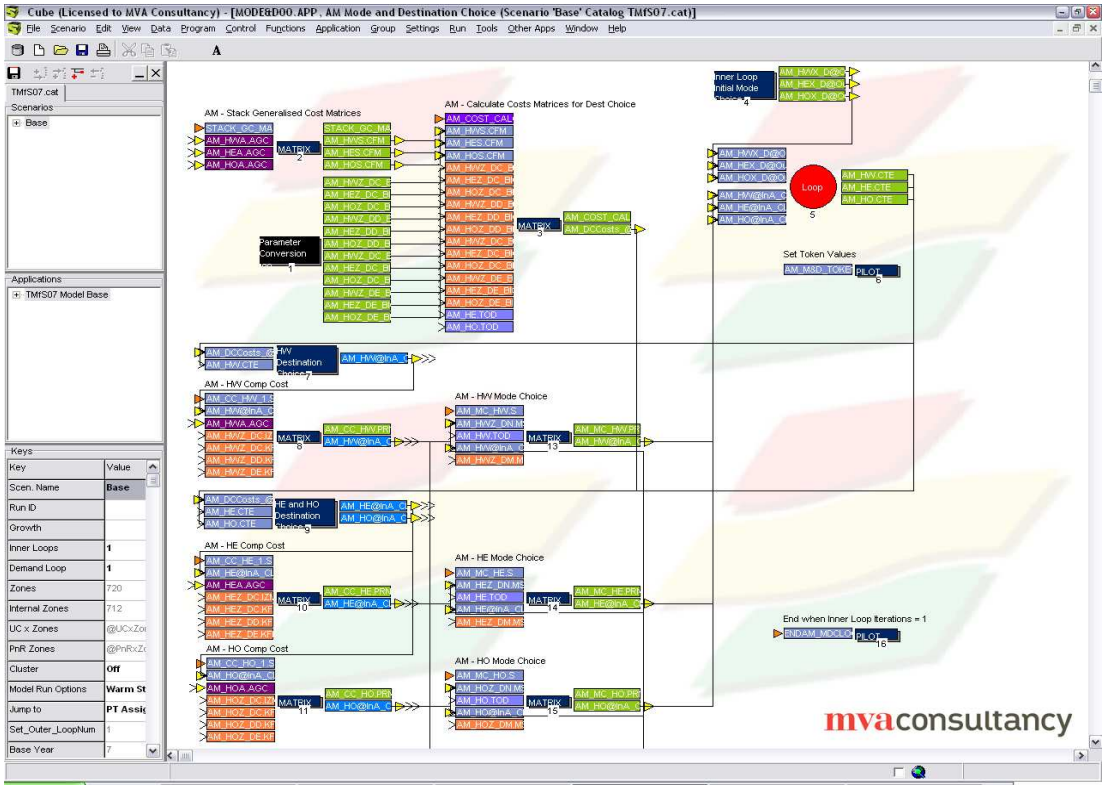

Figure 4.3 – Mode and Destination Choice Layout

4.3 HOV Modelling

4.3.1 The High Occupancy Vehicle (HOV) Modelling module is an optional extra which can be turned on using the appropriate catalog key. *However, currently the functionality is not included in the Highway script, though the necessary steps are included in the demand model and generalised cost modules.*

4.3.2 Any HOV scripting will be described when it is included in a subgroup even though the full functionality is not available.

4.4 P&R Site Choice

4.4.1 The P&R site choice subgroup sits within the demand model directly after mode and destination choice. It splits the P&R demand amongst the available sites.

4.4.2 The P&R subgroup works separately for each travel purpose. It calculates P&R demand for Home-Based Work, Home-Based Employers Business and Home-Based other simultaneously. The model then outputs data by site for each travel purpose.

4.4.3 The P&R module outputs AM From-Home and PM To-Home matrices by purpose and mode. These are then added in to the Highway and Public Transport assignment matrices for route choice.

P&R Costs

4.4.4 P&R costs are based on the average cost via all sites weighted by the demand for each site. This provides a detailed representation of the cost of P&R in the demand model and also allows for feedback to the demand model if P&R site choice changes.

4.4.5 The basic premise of the site choice model is to apply a logit model across all available sites for each *ij* pair using all available sites based on generalised costs derived for each site. These generalised costs include the tangible aspects of P&R sites, such as capacity, user charges and journey times by road and PT as well as an 'attractiveness' factor to account for other elements that are not explicitly modelled.

4.4.6 The available capacity at each P&R site is represented by two figures

- Near Capacity – this is the formal car park capacity; and
- Far Capacity – this represents the limit of available off-street parking.

4.4.7 If a far capacity is set, a penalty is applied to the next iteration of 'Att' (see below) to deter further demand at the site. It should only be used where there is observed data to on which to base a value on far capacity. At present, such data is not readily available and hence no site in the current base year or future year reference case scenarios has a far capacity applied at this time which has the effect of ignoring the penalty.

4.4.8 The P&R model contains an iterative procedure which adjusts site attractiveness relative to demand. The concept behind this iteration is that as more people use P&R, a site may become fuller and therefore the attractiveness of such a site will change. A consequent rebalance is then required in order to distribute demand to reflect expected user behaviour.

4.4.9 Pen is the penalty incurred for exceeding far capacity and is zero if this is not exceeded. If far is coded as zero then no penalty can be incurred.

4.4.10 It should be noted that there is a damping mechanism in place within this equation where the current Att is damped against the previous version. This is incorporated to encourage stability in the iterative process in a similar way to the damping process within the overall demand model.

4.4.11 The P&R process iterate until one of three conditions is met:

- the maximum change in attractiveness factor *Att* at all sites falls below a limit on a set number of consecutive iterations;
- a maximum P&R loop is reached, which is currently set at 20 iterations of site choice; or
- the maximum change in demand at all sites falls below a threshold value.

4.4.12 These threshold values and maximum loop numbers are able to be set individually by the user. Values have been calibrated which provide an appropriate balance of freedom and run time to achieve an acceptable level of convergence and stable outputs.

4.4.13 Figure 4.5 shows the top level of the P&R model subgroup. The MATRIX step in the top left is used to calculate the number of sites in the input file. This is then used to control the loop controls in the following steps.

4.4.14 Figure 4.6 shows the layout within a purpose specific subgroup, with the two subgroups described in the following figures. Figure 4.7 shows the contents of the first subgroup which calculates the site choice proportions. Figure 4.8 shows the second subgroup where the demand is split by site and converted to legs.

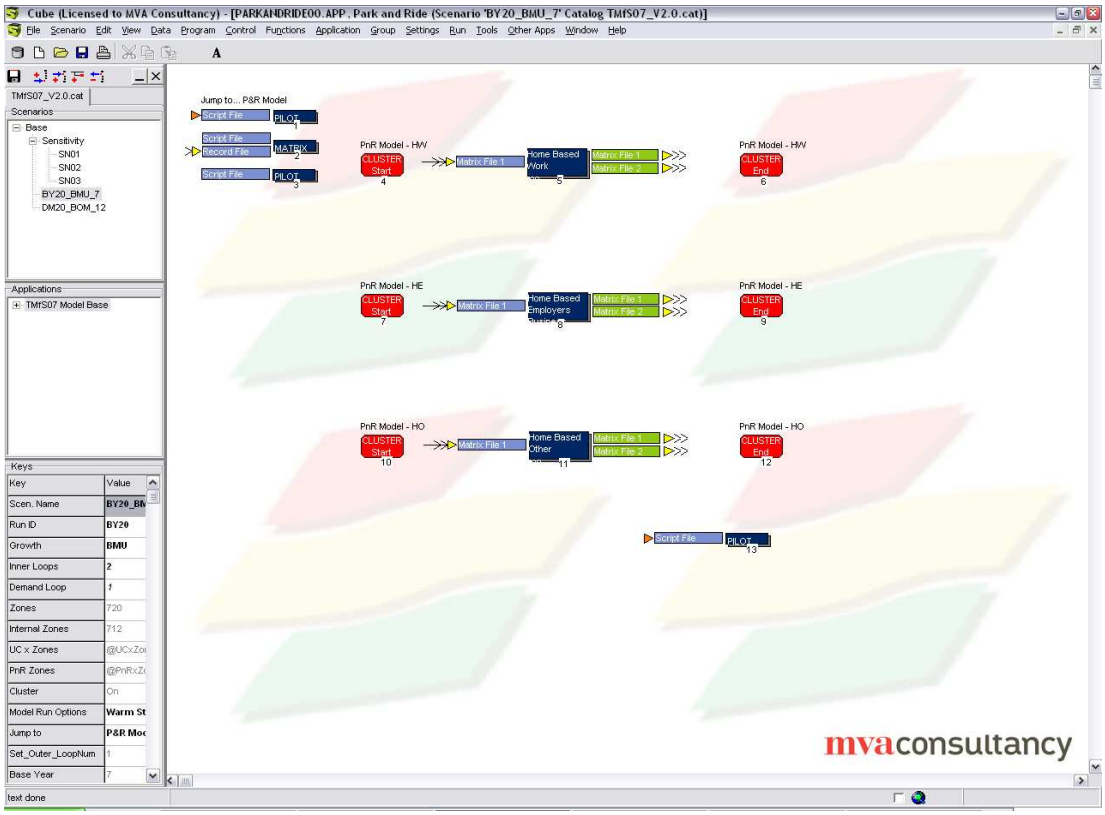

Figure 4.4 – P&R Model – Top Level Layout

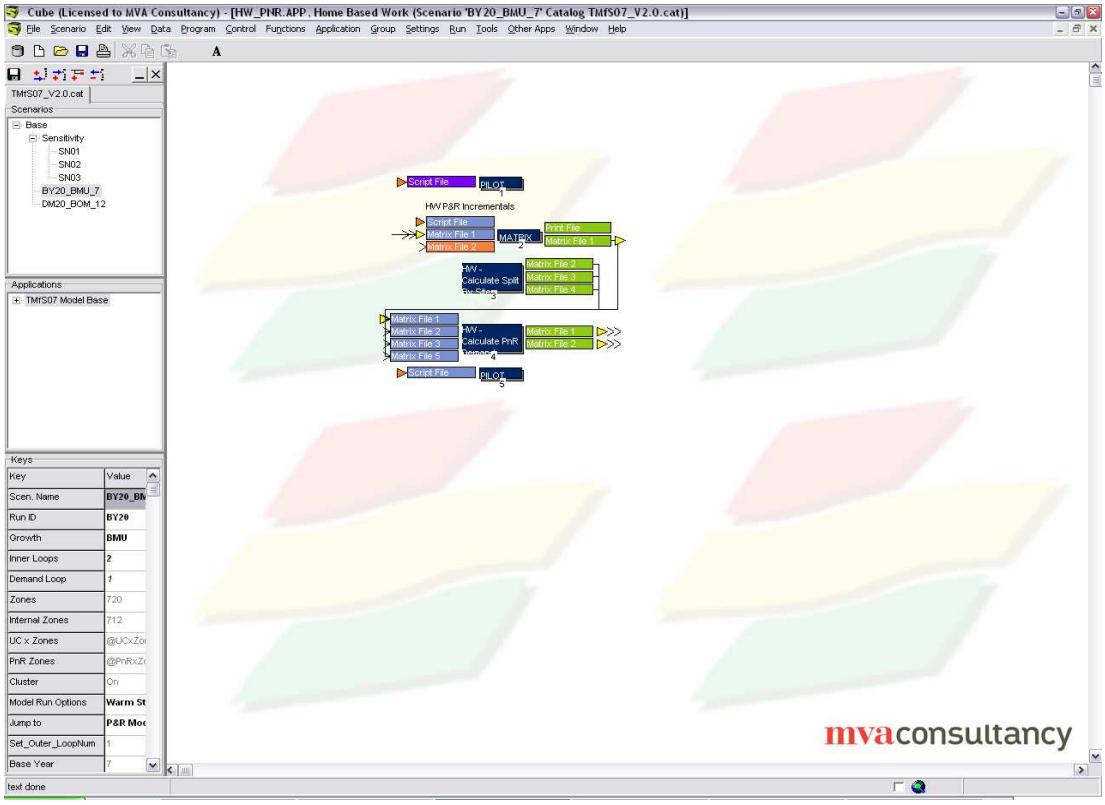

Figure 4.5 – P&R Model – Level 2 Layout

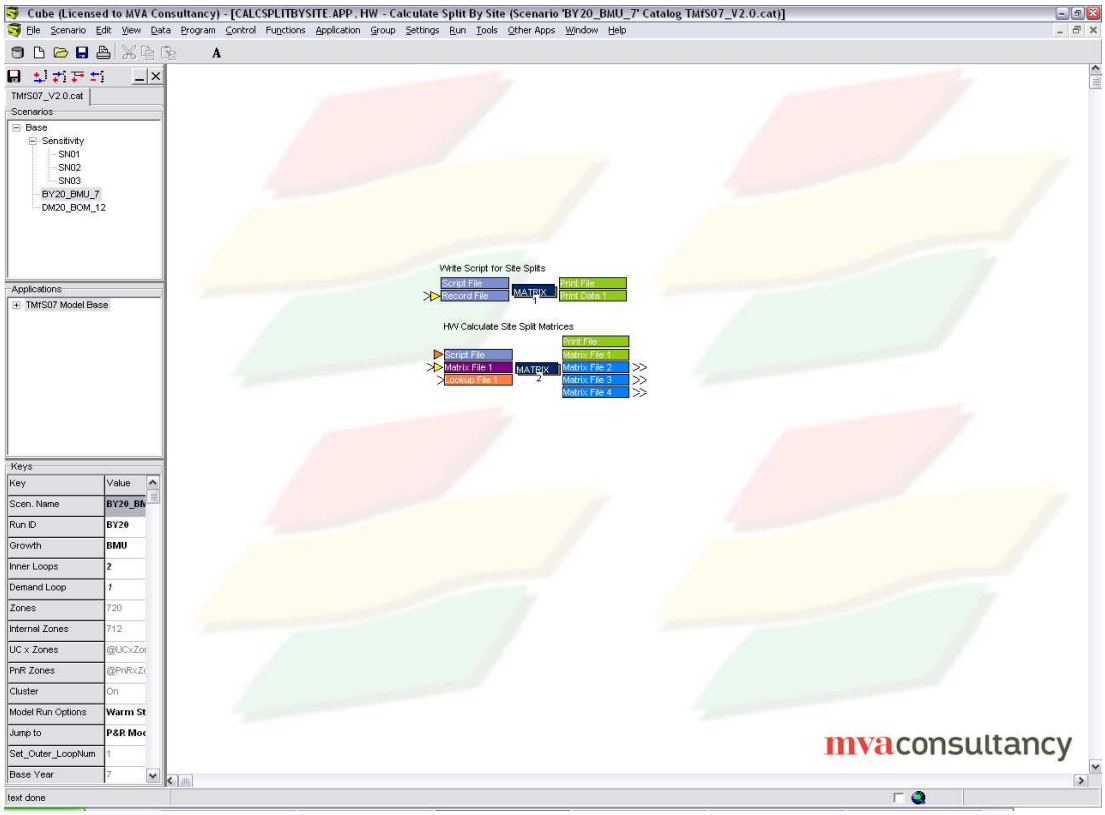

Figure 4.6 – P&R Model – Site Choice Layout

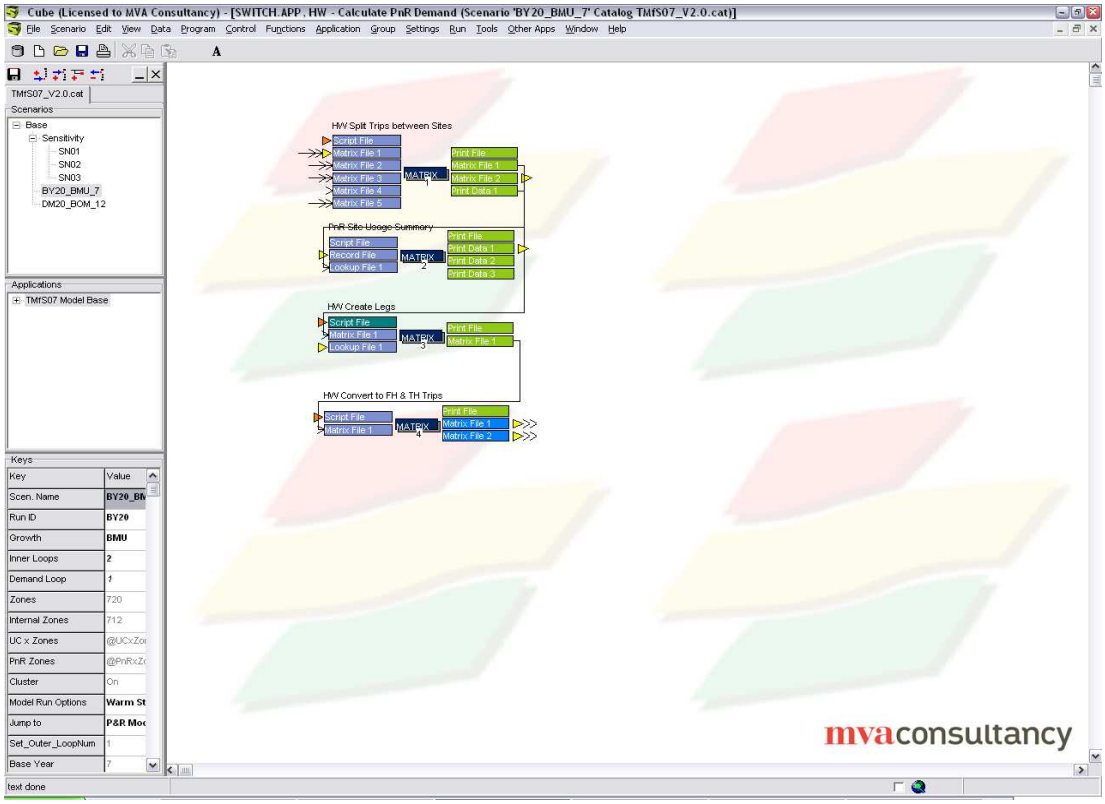

Figure 4.7 – P&R Model – Create P&R Legs

4.5 Creation of To-Home and Non-Home based trips (Reverse Factoring)

4.5.1 The outputs from the Mode and Destination Choice model are From-Home matrices by period (AM & IP) and purpose (work, employers business and other). To-Home matrices are created using a matrix of proportions of return journey times (i.e. a work trip in the AM peak may have 5%, 15% and 80% chances of returning in the AM, IP and PM periods respectively).

4.5.2 From-Home education trips are read in (these are not included in the full demand model) and included in the To-Home process. The To-Home matrices are then transposed to be combined with the From-Home trips.

4.5.3 From-Home trips for the PM peak are created by factoring the IP matrices. To-Home matrices are then created in the same way as for the other periods.

4.5.4 Non-home based trips are created using the following process.

- Trips ends are created from the From and To-Home matrices;
- These are factored based on Non-Home based rates (in a similar process to the To-Home production); and
- Furnessing of trip ends produces Non-Home based matrices.

4.5.5 If Macro Time of Day (MTOD) modelling is switched on then Pre-Peak matrices (MTOD allows trips to move out of the AM peak to the pre-peak. See below for more details) are added to the From-Home matrices so that To-Home and Non-Home based trips are created for this demand.

4.5.6 IF HOV modelling is implemented then the Pre-Peak matrices are split using the AM peak high occupancy proportions.

4.5.7 Figure 4.9 shows the layout of the Reverse Factoring subgroup. The To-Home calculations are shown on the left-hand side, the process to create trip ends for the Non-Home based demand is in the centre and the Non-Home Based calculations are shown on the right.

4.5.8 Figure 4.10 shows the layout of a To-Home subgroup. The programs on the left create the To-Home trips. The programs on the right calculate the Non-Home based trips ends generated by the From and To-Home demand.

4.5.9 Figure 4.11 shows the layout of a Non-Home based subgroup. Here a deterrence function is used to furness the input trip ends to produce Non-Home based demand.

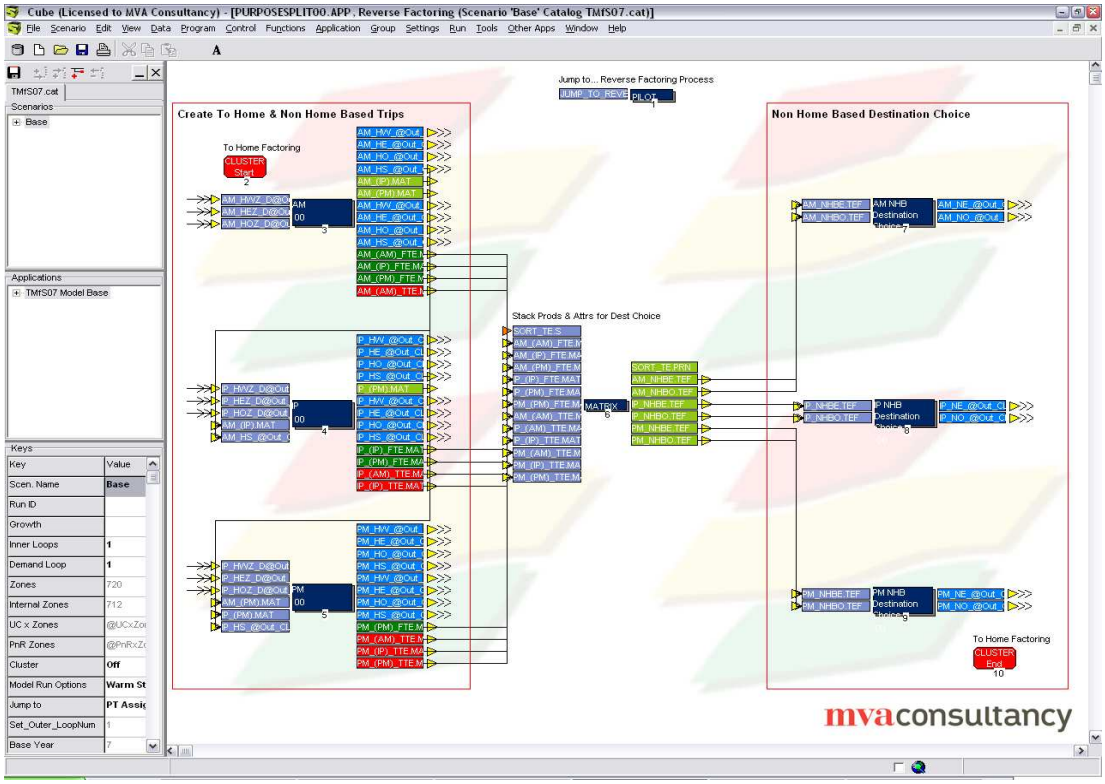
Cube (Licensed to MVA Consultancy) - [PURPOSESPLIT00.APP, Reverse Factoring (Scenario 'Base' Catalog TMfS07.cat)]
Create To Home & Non Home Based Trips
Non Home Based Destination Choice
Jump to... Reverse Factoring Process
Stack Prods & Attrs for Dest Choice
To Home Factoring
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Figure 4.8 - Reverse Factoring Subgroup Layout

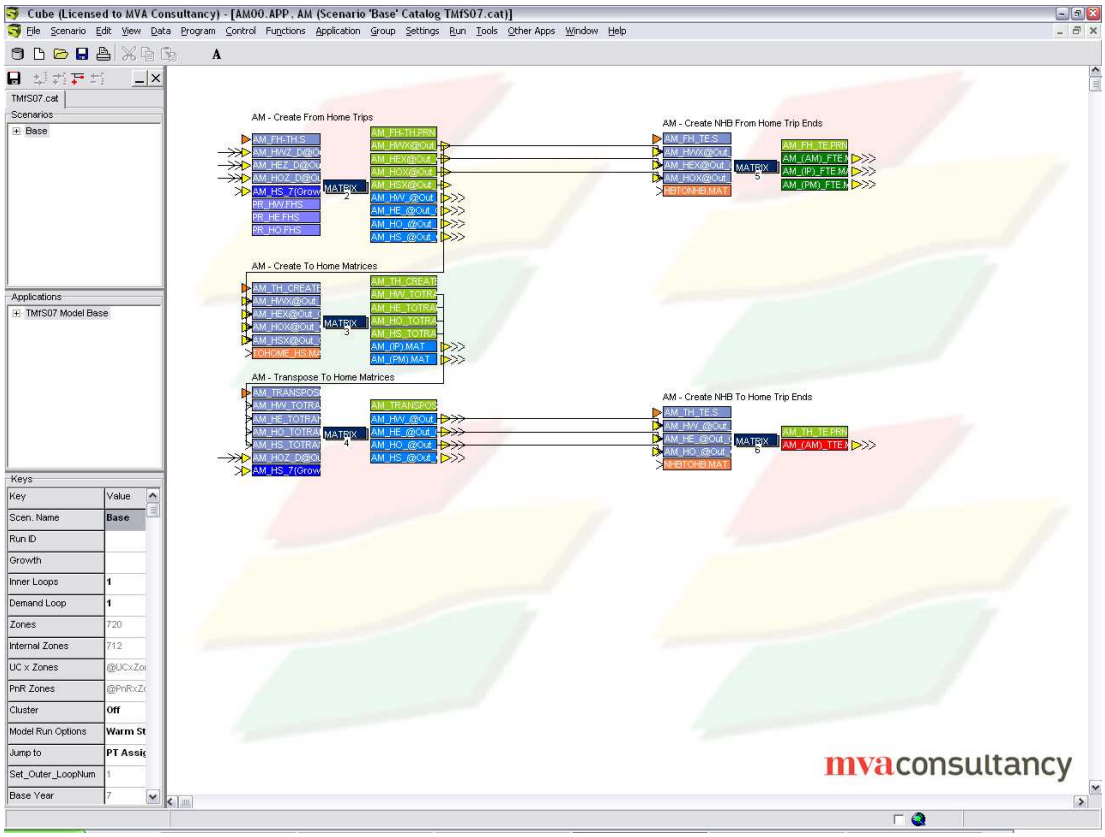
Cube (Licensed to MVA Consultancy) - [AM00.APP, AM (Scenario 'Base' Catalog TMfS07.cat)]
AM - Create From Home Trips
AM - Create NHB From Home Trip Ends
AM - Create To Home Matrices
AM - Transpose To Home Matrices
AM - Create NHB To Home Trip Ends
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Figure 4.9 – To-Home Trip Creation Layout

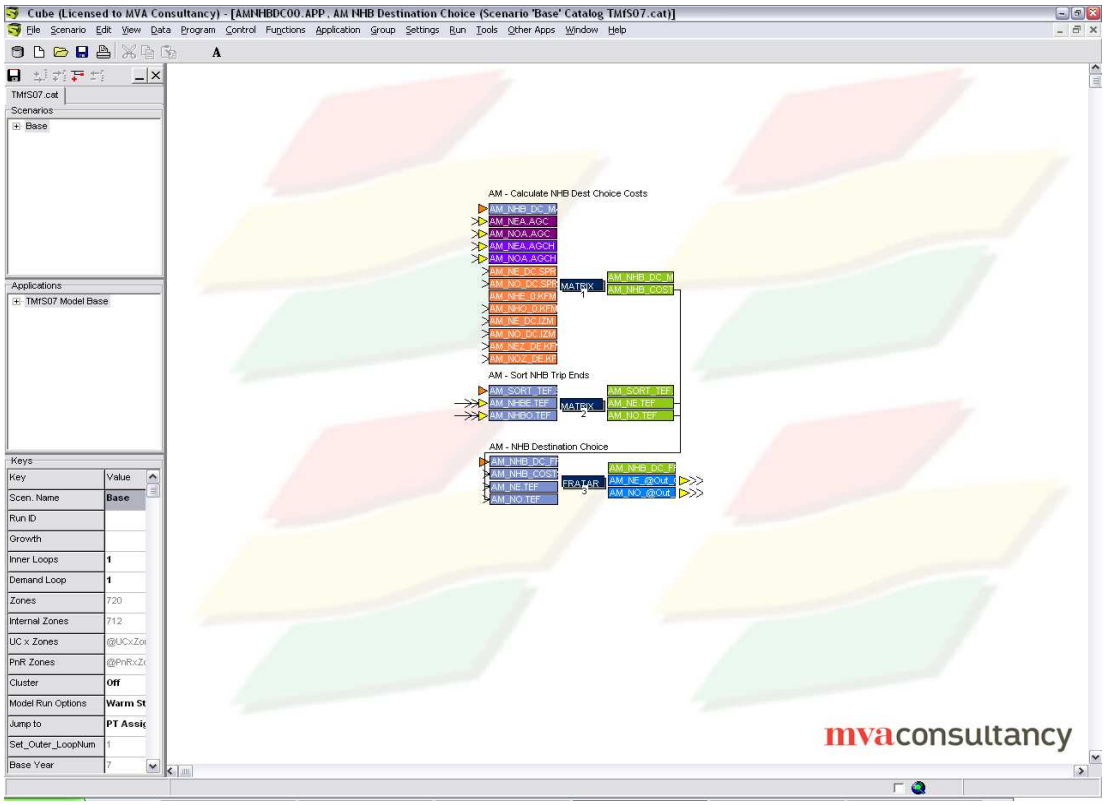

Figure 4.10 – Non-Home Based Trip Creation Layout

4.6 Creation of Assignment Matrices

4.6.1 This process combines all the demand from the reverse factoring and P&R models and converts it to peak hour assignment demand matrices. These are then passed to the assignment models.

4.6.2 The processes undertaken in this subgroup are as follows.

- Combine demand model purposes (work, employer's business, other and education) to assignment model user classes (in-work, non-work commute and non-work other);
- P&R legs added to the appropriate matrix;
- Factor to peak hour matrices;
- Convert the highway demand to vehicles;
- Add external-external demand;
- Add long distance trips;
- Apply Incremental Adjustment Factoring process (a combination of additive and multiplicative); and
- Apply trip damping by averaging between the last and current iterations.

4.6.3 Figure 4.12 shows the top level of this subgroup, with Figure 4.13 showing the AM peak subgroup.

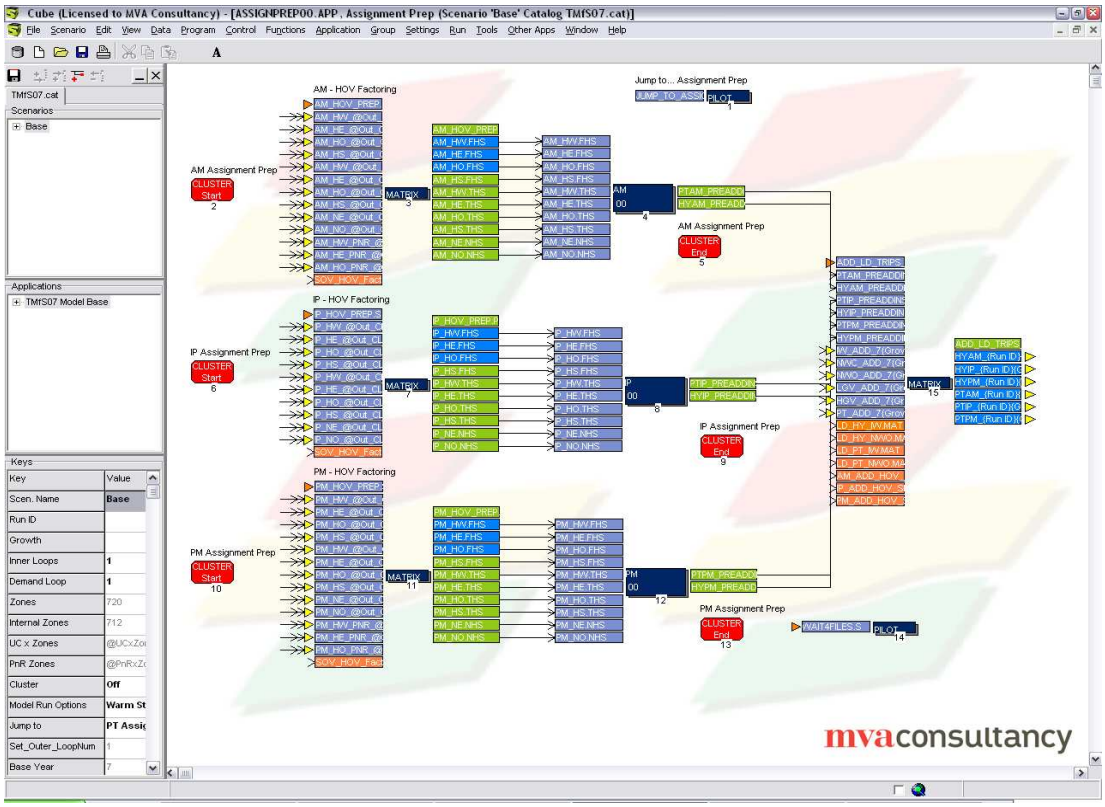
Cube (Licensed to MVA Consultancy) - [ASSIGNPREP00.APP, Assignment Prep (Scenario 'Base' Catalog TMfS07.cat)]
AM - HOV Factoring
IP - HOV Factoring
PM - HOV Factoring
AM Assignment Prep
IP Assignment Prep
PM Assignment Prep
Jump to... Assignment Prep
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Figure 4.11 – Creation of Assignment Matrices – Top Level

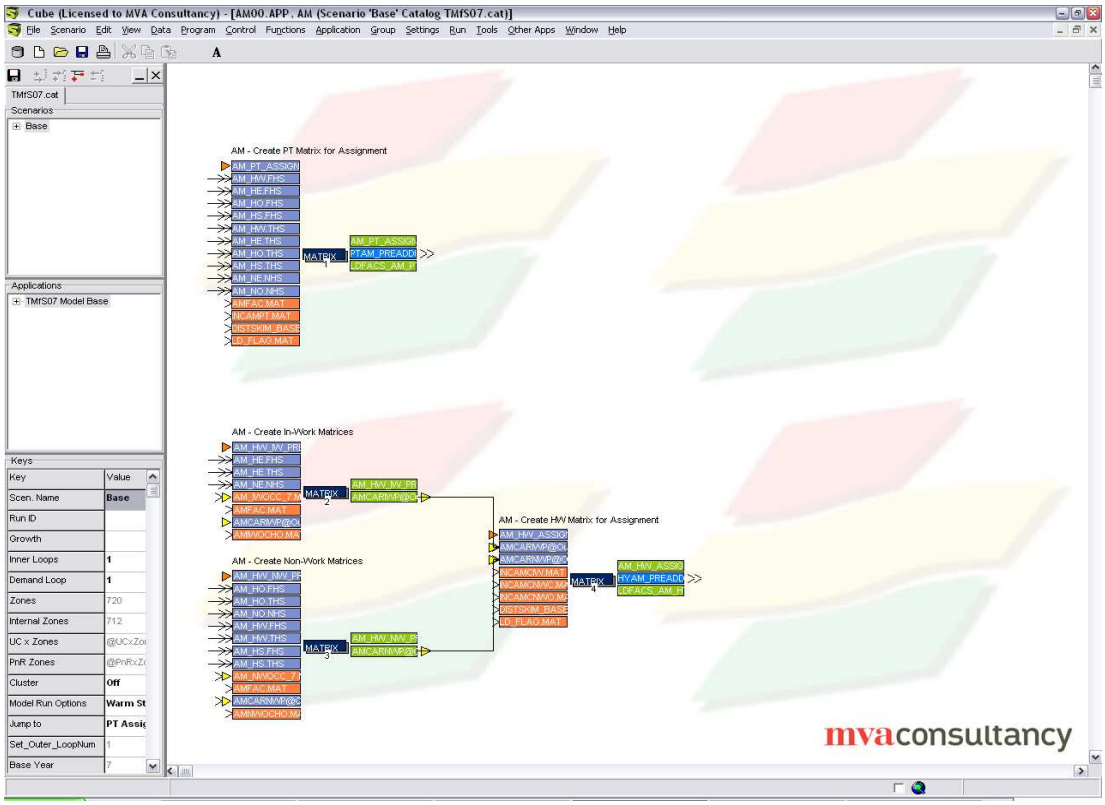
Cube (Licensed to MVA Consultancy) - [AM00.APP, AM (Scenario 'Base' Catalog TMfS07.cat)]
AM - Create PT Matrix for Assignment
AM - Create In-Work Matrices
AM - Create Non-Work Matrices
AM - Create HW Matrix for Assignment
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Figure 4.12 – Creation of Assignment Matrices – Level 2

5 Assignment Models

5.1 Highway Model

5.1.1 The Highway Model is a relatively standard Voyager HIGHWAY assignment taking distance, time and tolls to create costs of travel for route choice and output costs skims for the demand model and a network for use in the PT model. There are five user classes assigned for each period.

- Car In-Work;
- Car Non-Work Commute;
- Car Non-Work Other;
- LGV; and
- HGV.

5.1.2 In addition to the assignment, an additional HIGHWAY step is run to skim costs from the final iteration. These are then used in the Land Use Model.

5.1.3 Figure 5.1 shows the top level layout of the Highway Assignment subgroup, showing the three period subgroups and the Cluster controls. Figure 5.2 shows the AM peak assignment process.

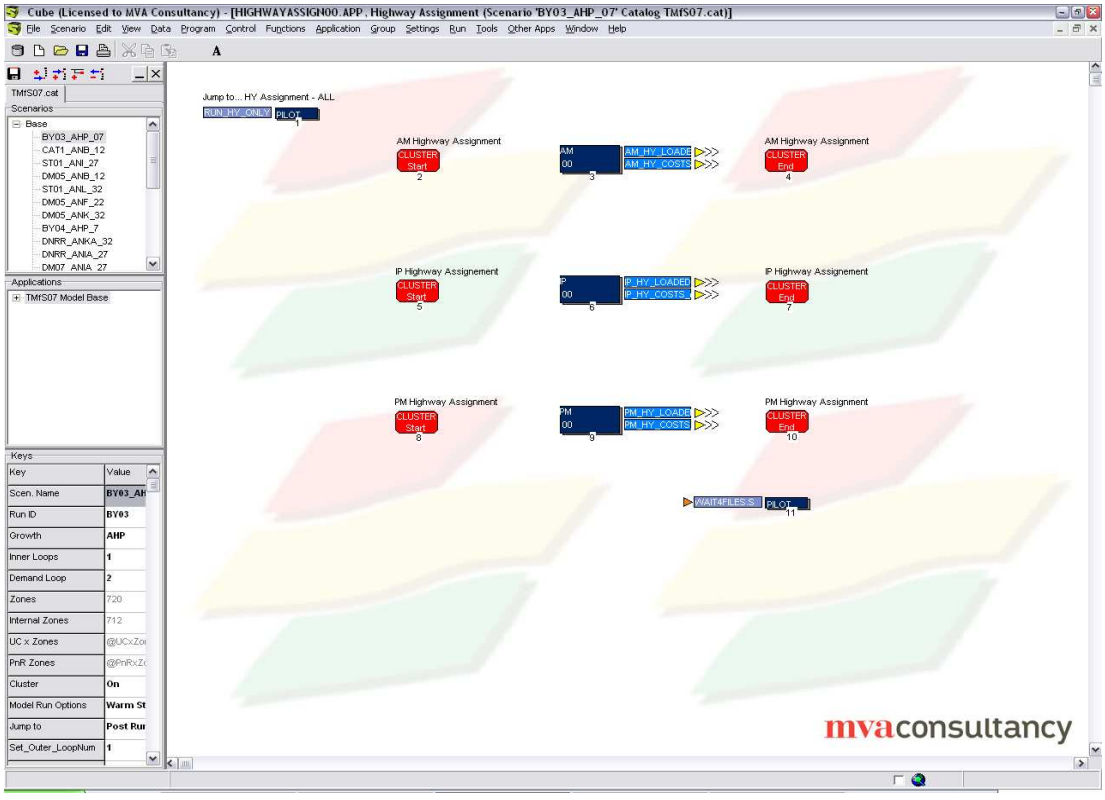
Cube (Licensed to MVA Consultancy) - [HIGHWAYASSIGN00.APP, Highway Assignment (Scenario 'BY03_AHP_07' Catalog TMfS07.cat)]
AM Highway Assignment
IP Highway Assignement
PM Highway Assignment
mvaconsultancy

Figure 5.1 – Highway Model – Top Level

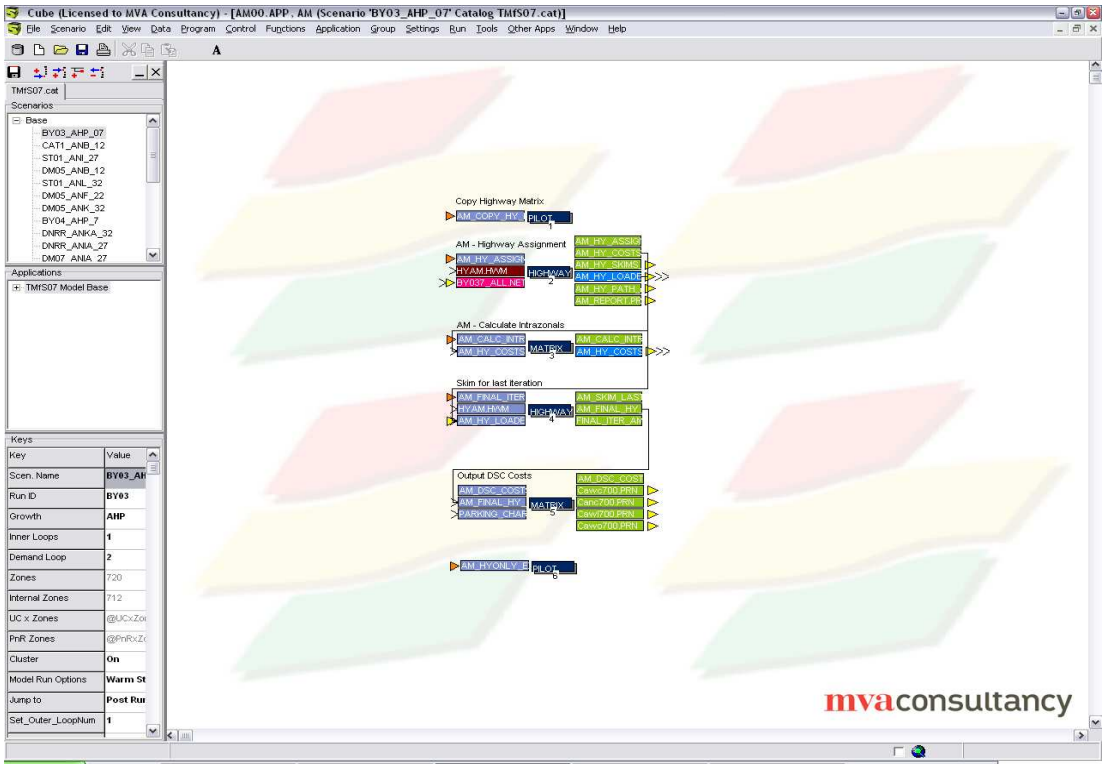

Figure 5.2 – Highway Model – Period Level

5.2 Public Transport Model

5.2.1 When running the Public Transport Model there is the option to run it on every loop, or just the first and last loops. If the PT assignment will not change much during the model run then the assignment can be run only twice to save on run time. On the intermediate loops the Generalised Costs are copied from the previous loop and renamed.

5.2.2 A Cube branch is used to control this process and is shown in Figure 5.3

5.2.3 Figure 5.4 shows the "Run PT Yes" subgroup. The PT model has four main processes

- Prepare Factors file by adding VOT figures for current year;
- Add PT links to output Highway network and calculate bus speeds form congested highway speeds. Also create Non-Transit legs;
- PT assignment – made up of five steps itself;
  - Route Enumeration (initial route choice and);
  - Route Evaluation (assignment)
  - Outputting of costs and calculating of intrazonals;
  - Combining of PT and Highway flow volumes in a single network; and
  - Output B&A data for rail nodes.
- Post Assignment Processing – Combining period networks, outputting costs for the Land Use Model and combining rail B&A data.

5.2.4 Figures 5.5 to 5.8 show the layout of each of these steps.

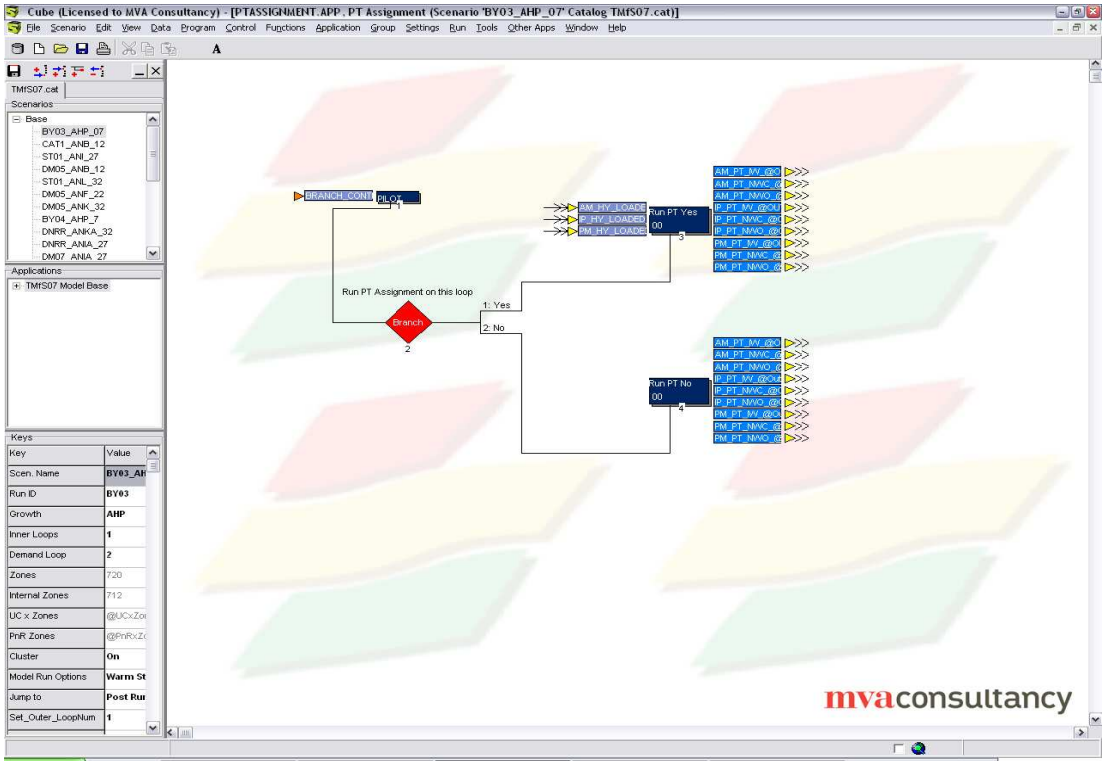
Cube (Licensed to MVA Consultancy) - [PTASSIGNMENT.APP , PT Assignment (Scenario 'BY03_AHP_07' Catalog TMfS07.cat)]
Run PT Assignment on this loop
Branch
1: Yes
2: No
Run PT Yes
Run PT No
mvaconsultancy

Figure 5.3 – Public Transport Branch

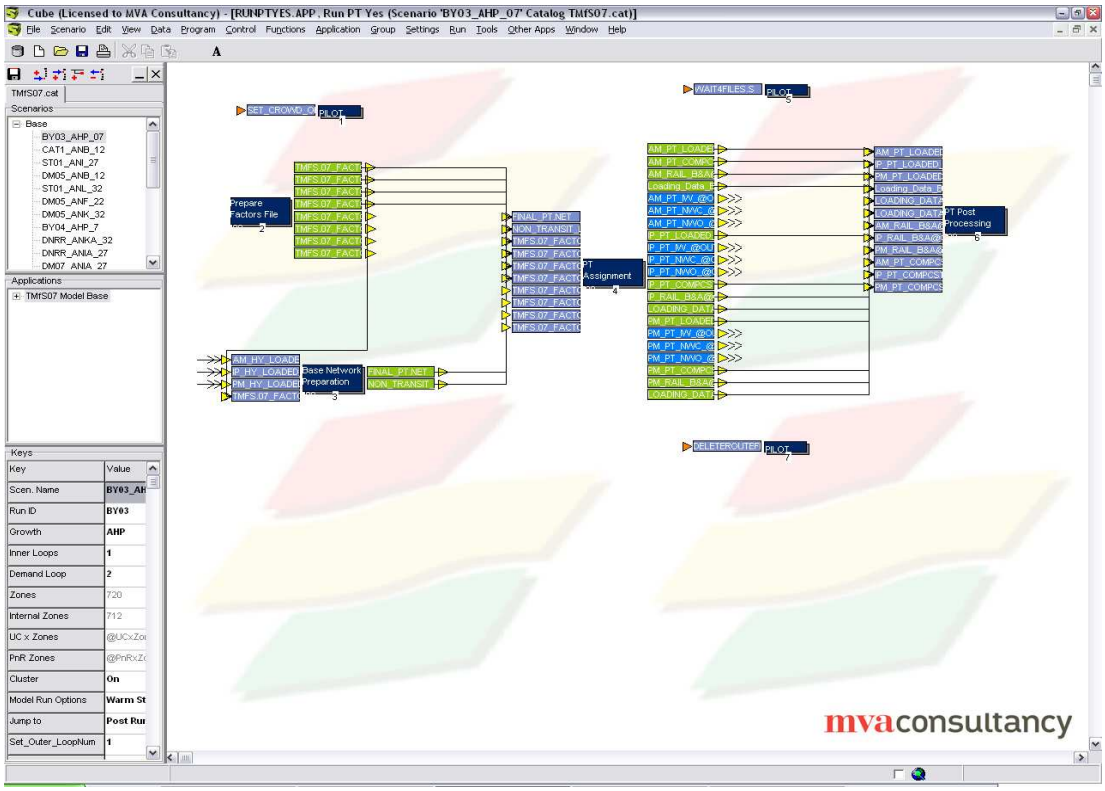
Cube (Licensed to MVA Consultancy) - [RUNPTYES.APP , Run PT Yes (Scenario 'BY03_AHP_07' Catalog TMfS07.cat)]
Prepare Factors File
Base Network Preparation
PT Assignment
PT Post Processing
mvaconsultancy

Figure 5.4 – Run PT Model Subgroup

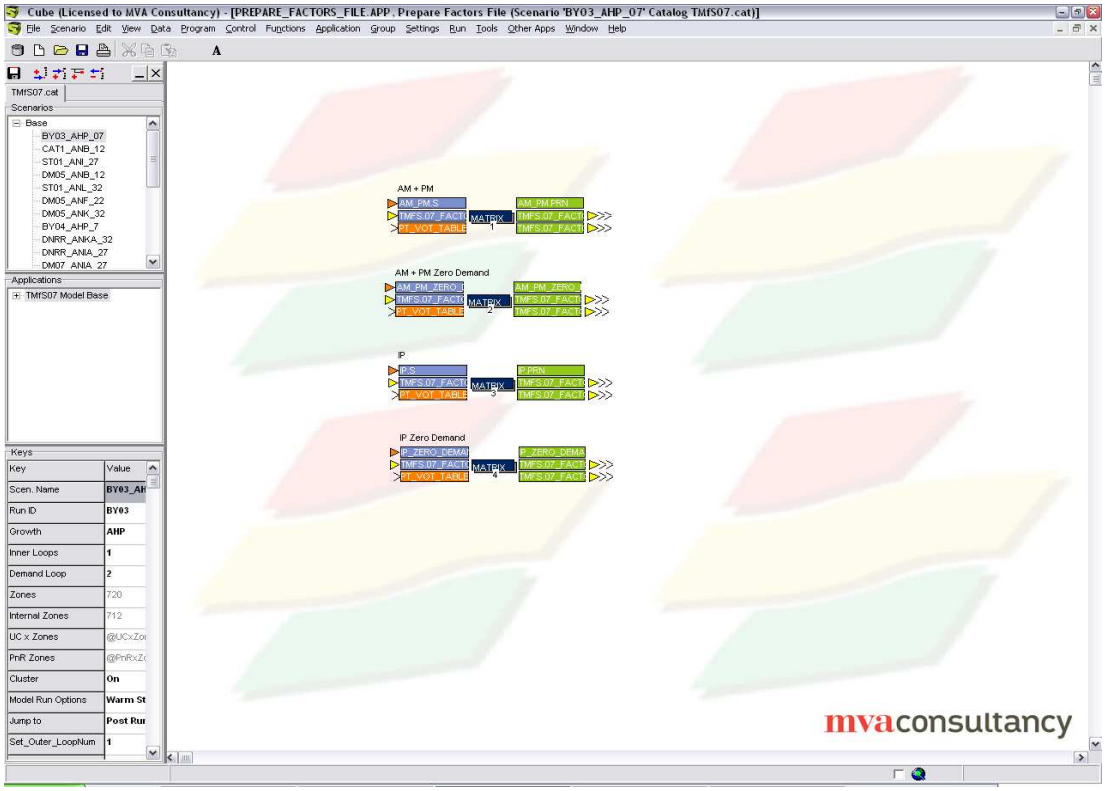

Figure 5.5 – Prepare Factors File

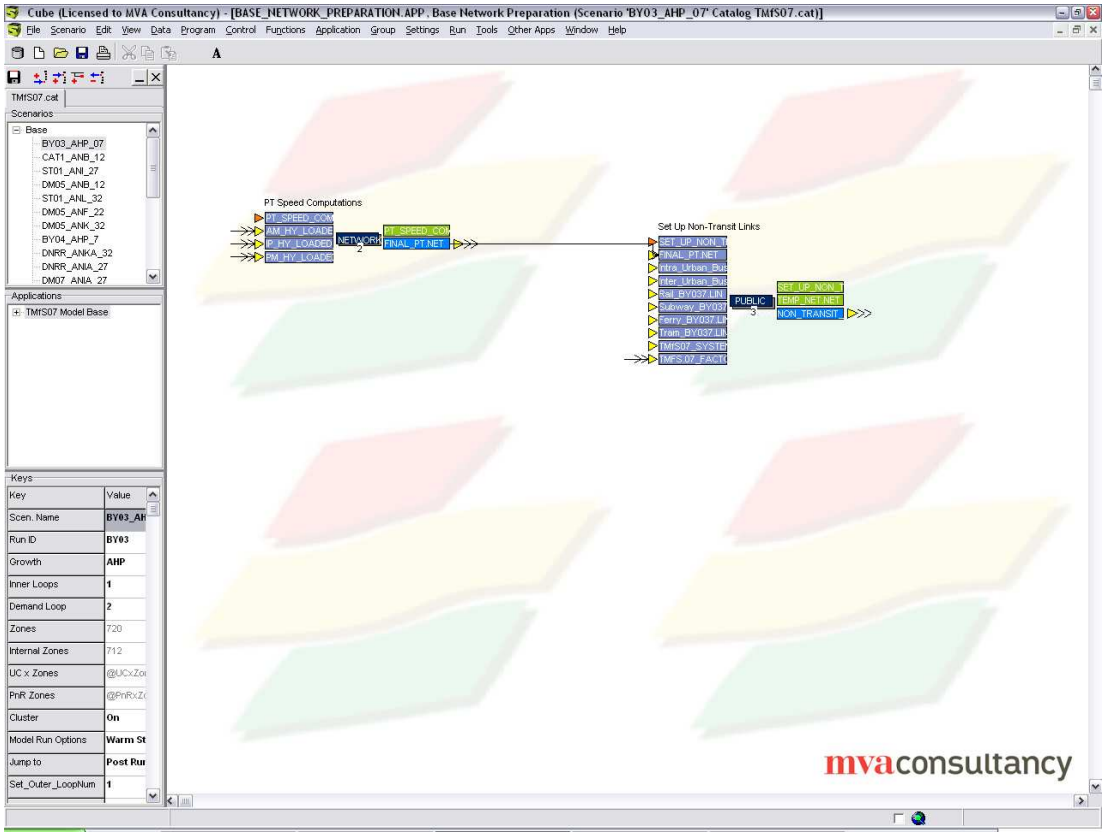

Figure 5.6 – Build PT Network from Highway Network

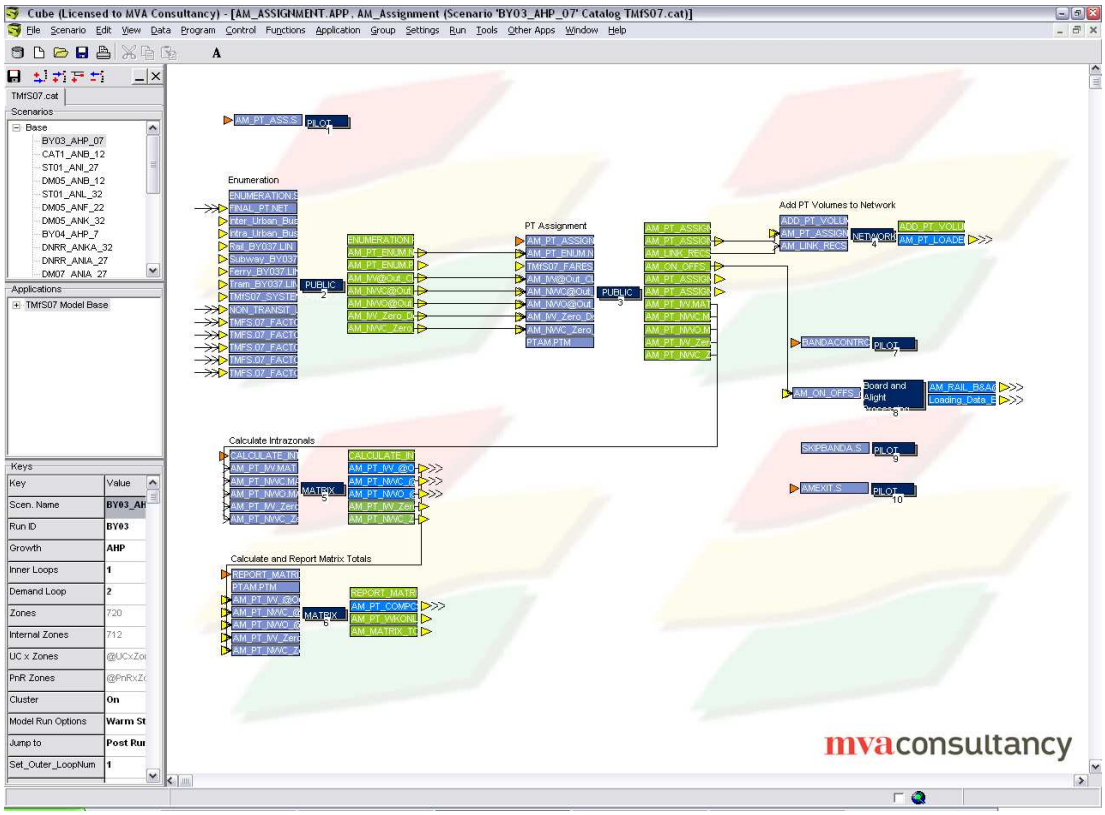
Cube (Licensed to MVA Consultancy) - [AM_ASSIGNMENT.APP, AM_Assignment (Scenario 'BY03_AHP_07' Catalog TMfS07.cat)]
Enumeration
PT Assignment
Add PT Volumes to Network
Calculate Intrazonals
Calculate and Report Matrix Totals
mvaconsultancy

Figure 5.7 – PT Model Assignment

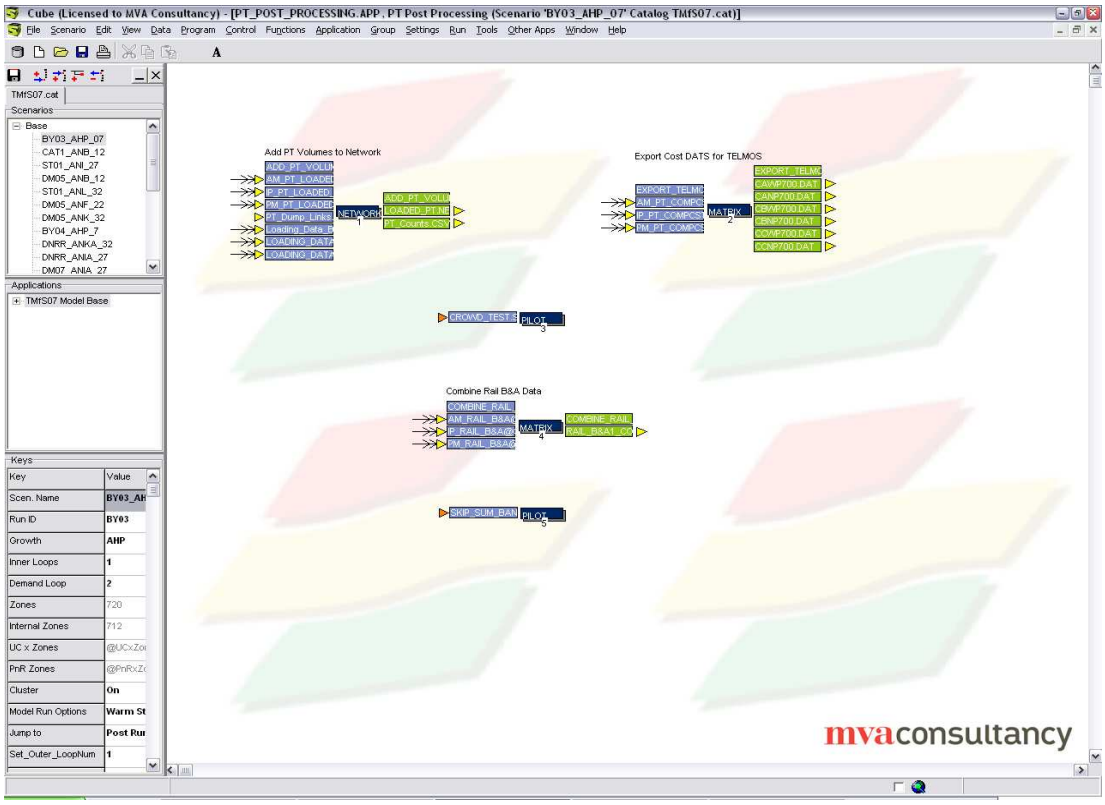
Cube (Licensed to MVA Consultancy) - [PT_POST_PROCESSING.APP, PT Post Processing (Scenario 'BY03_AHP_07' Catalog TMfS07.cat)]
Add PT Volumes to Network
Export Cost DATS for TELMOS
Combine Rail B&A Data
mvaconsultancy

Figure 5.8 – Post Assignment Processing

6 Generalised Costs and Convergence Stats

6.1 Generalised Costs

6.1.1 This subgroup takes the generalised costs skims from the assignment matrices and converts them into a format suitable for input to the next loop of the demand model. This is done in three steps

- Convert costs from user classes to purposes
  - In Work = Employers Business & Non-Home Based Employers Business;
  - Non-Work Commute = Work; and
  - Non-Work Other = Other & Non-Home Based Other.
- Calculate Average Costs;
  - AM Average Costs = (AM + PM^T) / 2 (parking charges added after calculating P&R costs)
  - IP Average Costs = (IP + IP^T) /2 + Parking Charges
- Calculate P&R costs
  - Set all costs to 999999;
  - For each P&R site calculate the cost for each possible movement, based on the origin and destination catchment areas. This is made up of the highway cost form the origin to the P&R site and the PT cost from the site to the destination;
  - Take the minimum of the current cost and the current minimum cost from the previous loops; and
  - After looping over all sites parking charges are added to the AM car costs. Any remaining 999999's in the P&R costs are set to zero.

6.1.2 Figure 6.1 shows the top level layout. Figure 6.2 shows the conversion from user classes to purposes. Figure 6.3 shows the P&R costs calculation layout.

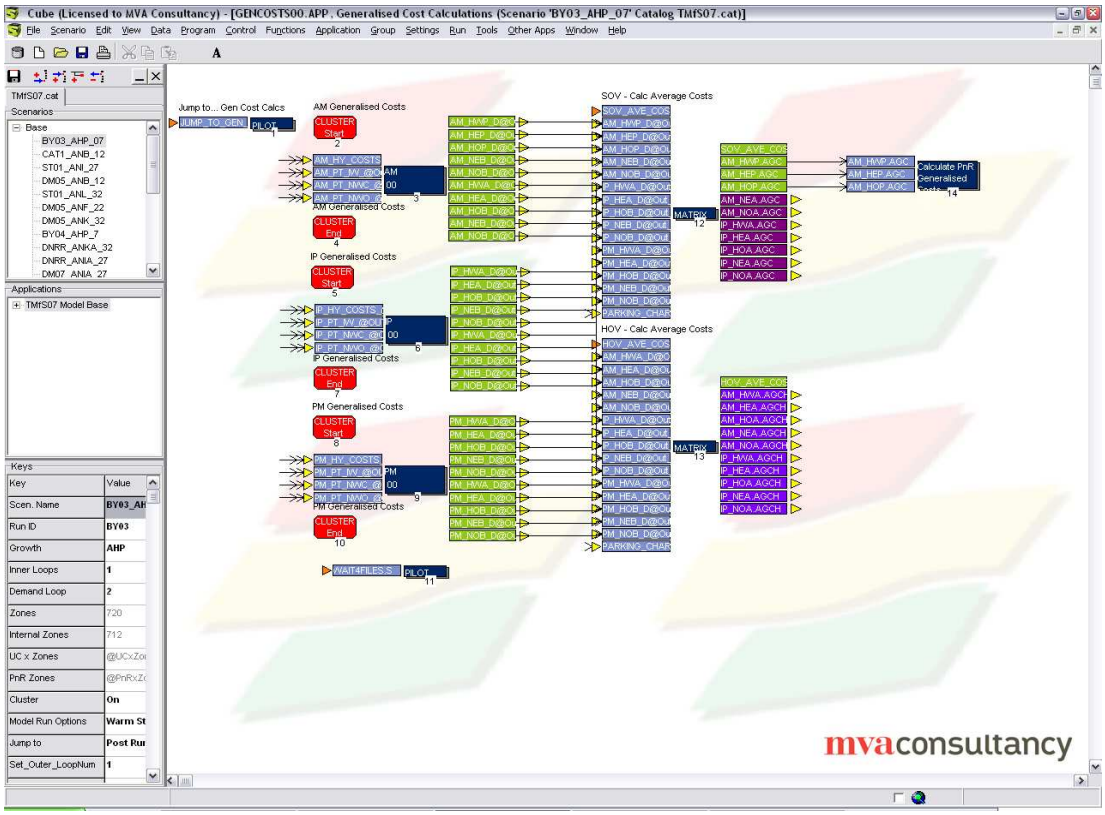

Figure 6.1 – Calculate New Average Generalised Costs – Top Level

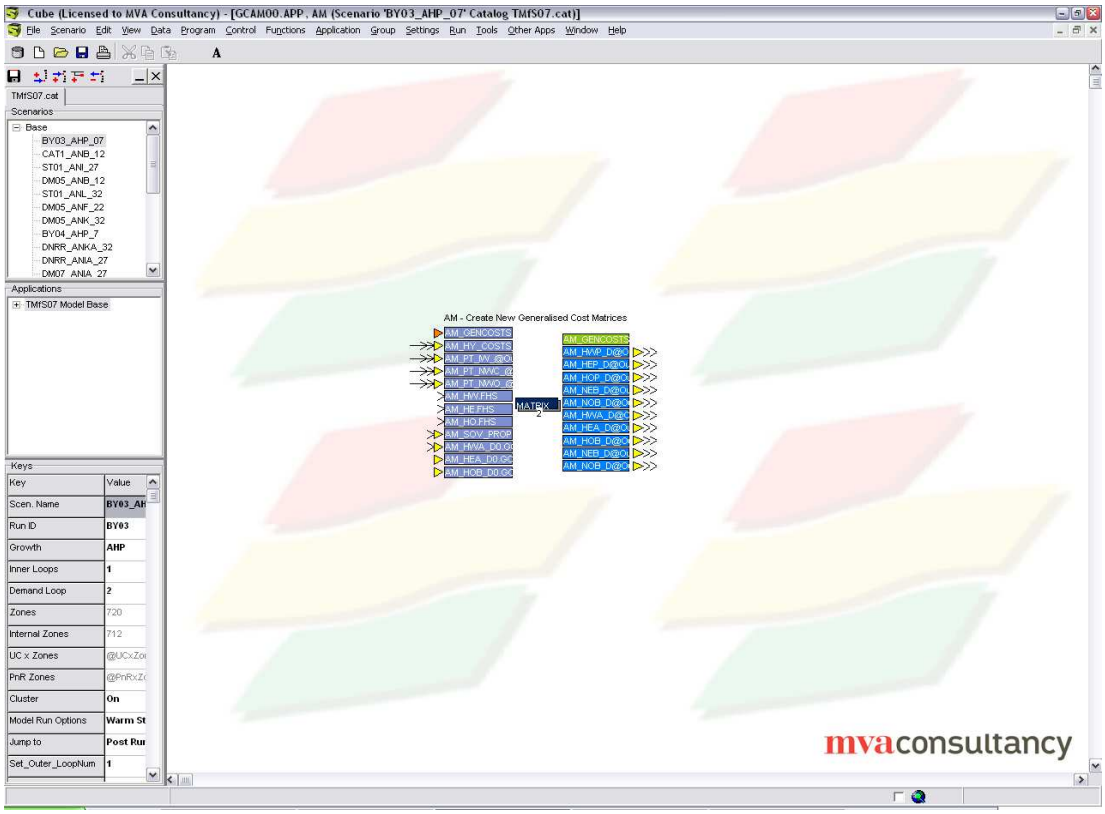

Figure 6.2 – Calculate New Average Generalised Costs – Level 1

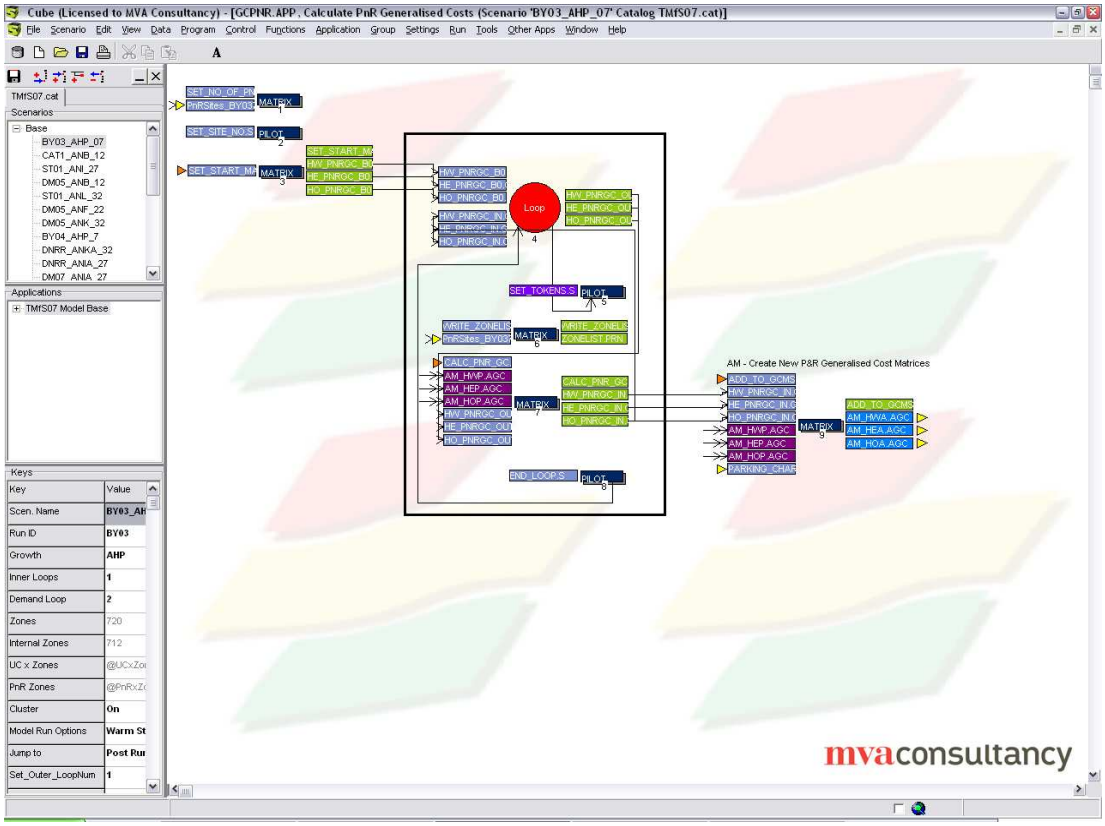

Figure 6.3 – Calculate P&R Generalised Costs

6.2 Convergence Stats

6.2.1 The number of iterations required for convergence depends upon the level of demand transferring between modes and is monitored using convergence statistics. The percentage gap statistics produced after every outer loop using the following formula

$$\%Gap_n = \frac{\sum_{ij} GC_{nij} \mid Tr_{nij} - Tr_{(n-1)ij} \mid}{\sum_{ij} GC_{nij} Tr_{nij}} * 100$$

where

GC_{nij} is the Generalised Costs from outer loop n;

Tr_{nij} is the Demand from outer loop n; and

$Tr_{(n-1)ij}$ is the Demand from outer loop n-1.

6.2.2 The current WebTAG guidance (Unit 3.10.4) is that the percentage gap should be less than 0.2%. The model is setup to run a pre-set number of loops set by a Catalog key, rather than continuing until convergence has been achieved. However, if once the model has finished the desired level of convergence has not been reached then the model can be

started from the end of the last loop and run additional outer loops until convergence is reached, by increasing the number of Outer Loops.

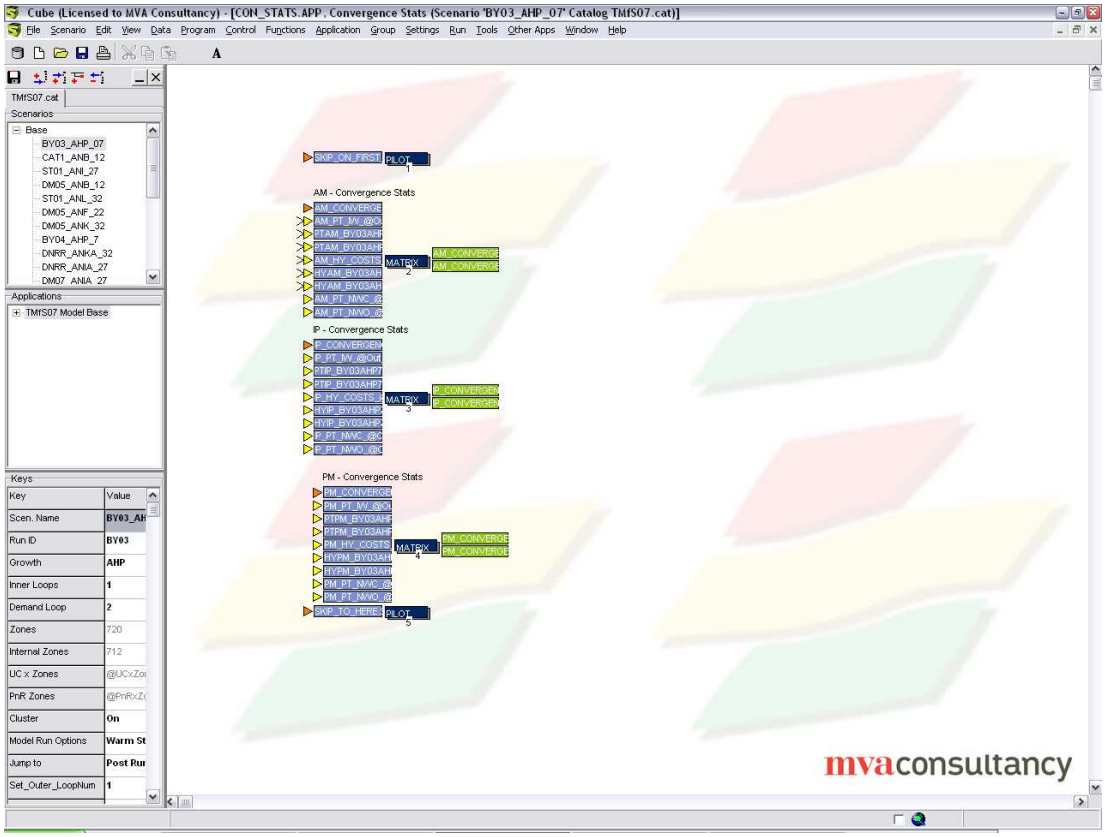

Figure 6.4 – Convergence Statistics

7 Post Run Analysis & Additional Modules

7.1 Introductions

7.1.1 This section gives details of additional/optional modules and post-run analysis modules available. These are:

- Post Run Analysis:
  - ENEVAL – environmental modelling;
  - Network Stats – vehicle kms and road travel times; and
  - ACCDNT – Accident analysis.
- Additional Modules:
  - Trip Frequency; and
  - Macro Time of Day.

7.2 Post Run Analysis

7.2.1 Figure 7.1 shows the top level layout of the Post Run Analysis subgroup, showing the ENEVAL, ACCDNT and Network Stats subgroups. The NETWORK step combines the output networks from the three assignment periods to create one all period network for use in all processes

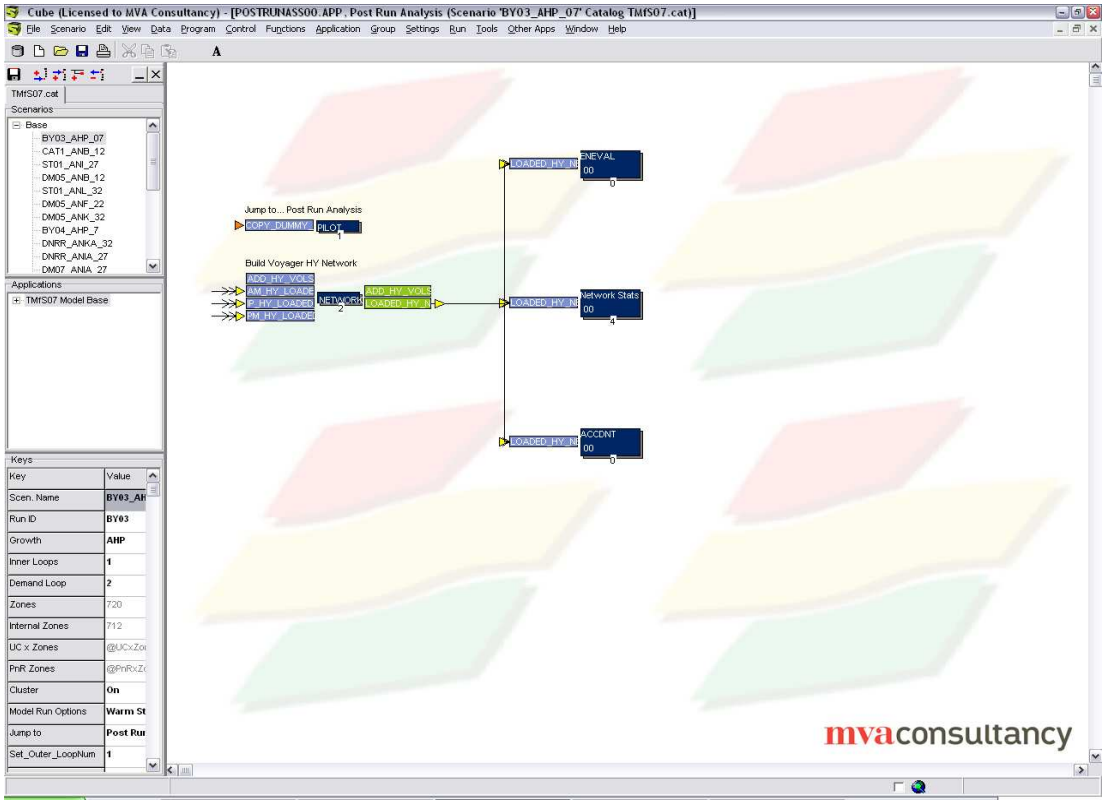

Figure 7.1 – Post Run Analysis – Top Level Layout

7.3 Post Run Analysis – ENEVAL

7.3.1 Environmental analysis is undertaken using the 'ENEVAL' procedure. This process calculates carbon emissions associated with road traffic (cars and goods vehicles) per link and at a local authority level. The procedure can also be used to output Carbon Dioxide Equivalent (CO_2(e)).

7.3.2 These outputs are displayed in tones (unless the 'output in kilograms' option is chosen by the user) and reflect annual emissions of carbon. The user can also output the data in emissions per kilometre format.

7.3.3 The following input files are required to operate the ENEVAL program and are all stored in the Params folder:

- Efficiency.dbf – car efficiency changes file;
- EmissionsA.dbf – emission rates file;
- Fleet Split.dbf – fleet composition file; and
- Fuel ConsumptionA.dbf – fuel consumption rate file.

7.3.4 The information in these files reflects emissions modelling guidance associated with WebTAG.

7.3.5 Figure 7.2 shows the ENEVAL layout.

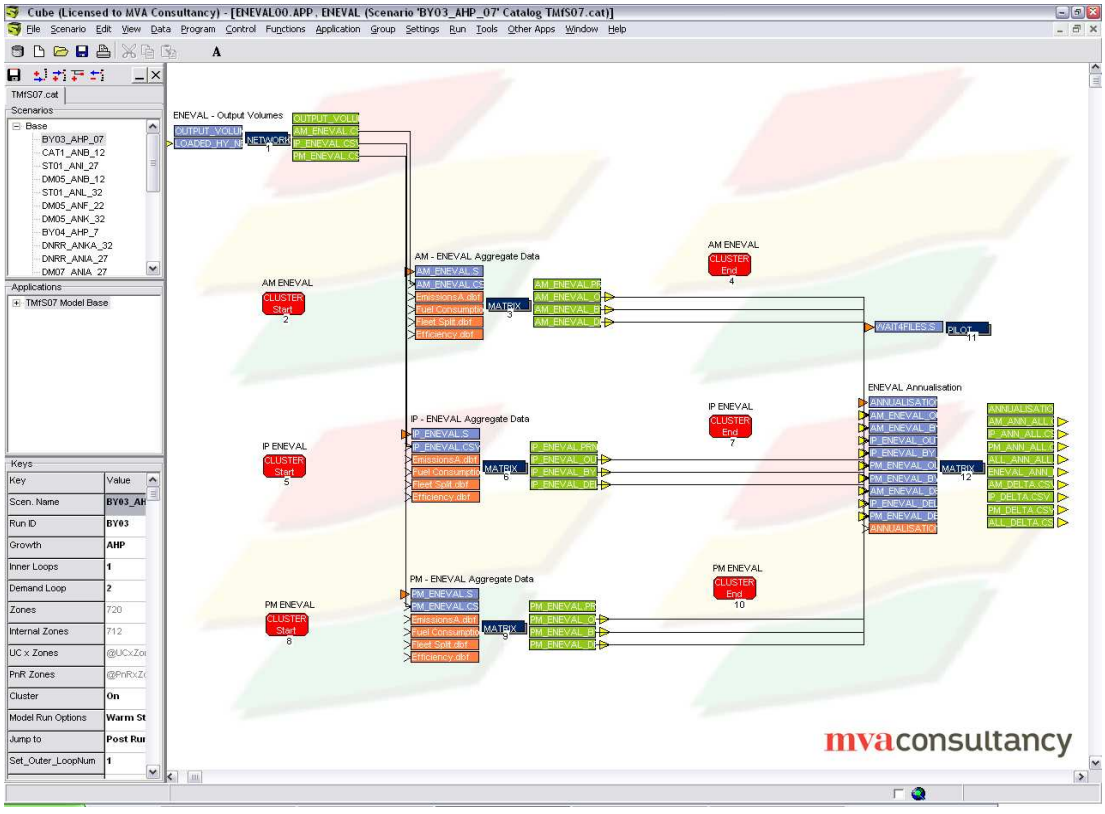

Figure 7.2 – ENEVAL layout

7.4 Post Run Analysis – Network Stats

7.4.1 This procedure calculates vehicle kilometres and road travel time for the five road user classes, (In-Work, Non-Work Commute, Non-Work Other, LGV and HGV) by modelled link and by local authority. This procedure is applied automatically following a demand or road model run. It can also be run for a model already converged from the warm start menu.

7.4.2 Figure 7.3 shows the Network Stats layout.

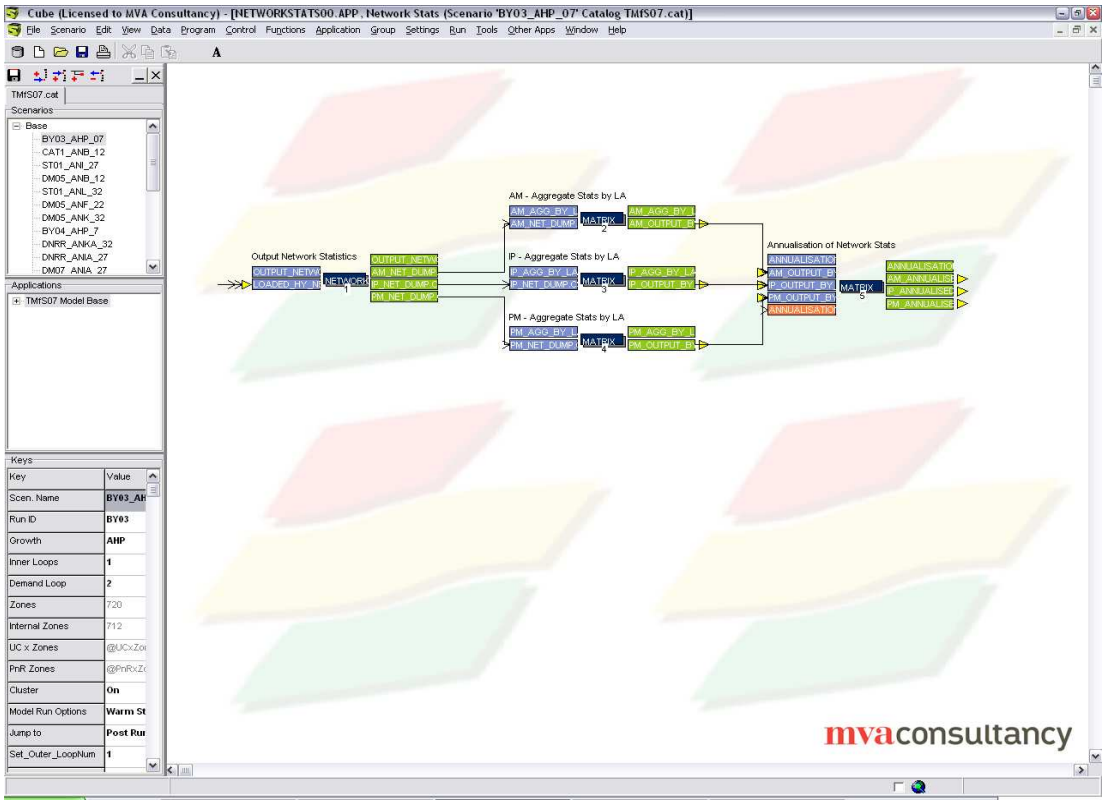
Cube (Licensed to MVA Consultancy) - [NETWORKSTATS00.APP, Network Stats (Scenario 'BY03_AHP_07' Catalog TMfS07.cat)]
AM - Aggregate Stats by LA
IP - Aggregate Stats by LA
PM - Aggregate Stats by LA
Output Network Statistics
Annualisation of Network Stats
mvaconsultancy

Figure 7.3 – Network Stats Layout

7.5 Post Run Analysis – ACCDNT

7.5.1 The accident analysis procedure calculates the number and cost of road traffic casualties by severity and road type. The procedure calculates accidents based on the number of vehicles travelling on each link and the average accident rate associated with different types of road.

7.5.2 Casualty and accident rates associated with different road types are contained within:

- "Casualty_Ratesv5.dbf"; and
- "Accident_Ratesv8.dbf".

7.5.3 These input files are located in the 'Params' folder. The financial costs associated with different severities of road accidents are located in the "Total_Costsv7.dbf" file, which is also located in the 'Params' folder.

7.5.4 The model output files include accident statistics by link or by local authority for each time period.

7.5.5 Figure 7.4 shows the ACCDNT layout.

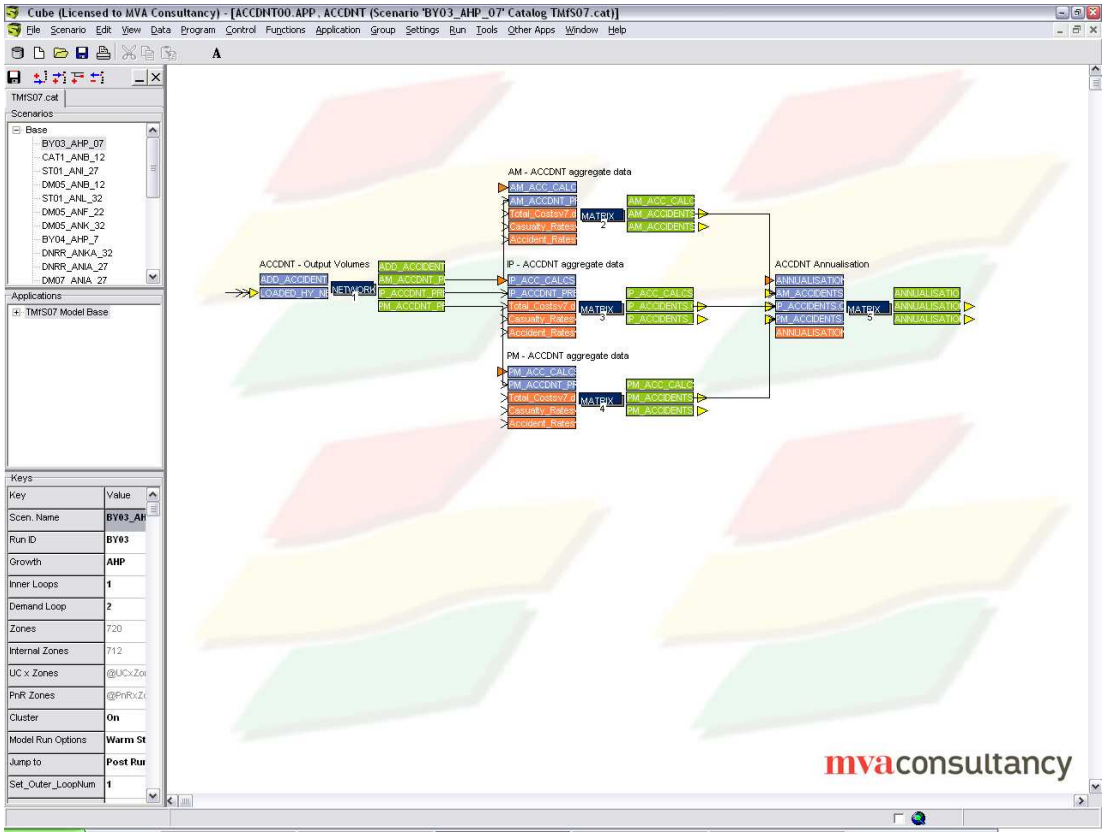
Cube (Licensed to MVA Consultancy) - [ACCDNT00.APP, ACCDNT (Scenario 'BY03_AHP_07' Catalog TMfS07.cat)]
AM - ACCDNT aggregate data
ACCDNT - Output Volumes
IP - ACCDNT aggregate data
ACCDNT Annualisation
PM - ACCDNT aggregate data
mvaconsultancy

Figure 7.4 – ACCDNT Layout

7.6 Additional Module – Trip Frequency

7.6.1 The Trip Frequency choice model allows changes the trip ends based on changes in the generalised cost of travelling between the test and base years. The origin trip ends total can increase or decrease, though the destination trip ends remain fixed.

7.6.2 The process is applied separately for each purpose. The outputs are new trip ends for all modes, purposes and car availability classes. These then form the inputs to the Mode and Destination choice model on the next loop.

7.6.3 The option of running the Trip Frequency module is controlled by a Cube branch control, shown in Figure 7.5. If Trip Frequency is switched off then the process simply copies the existing trips ends and renames them. Figure 7.6 shows the actual Trip Frequency process.

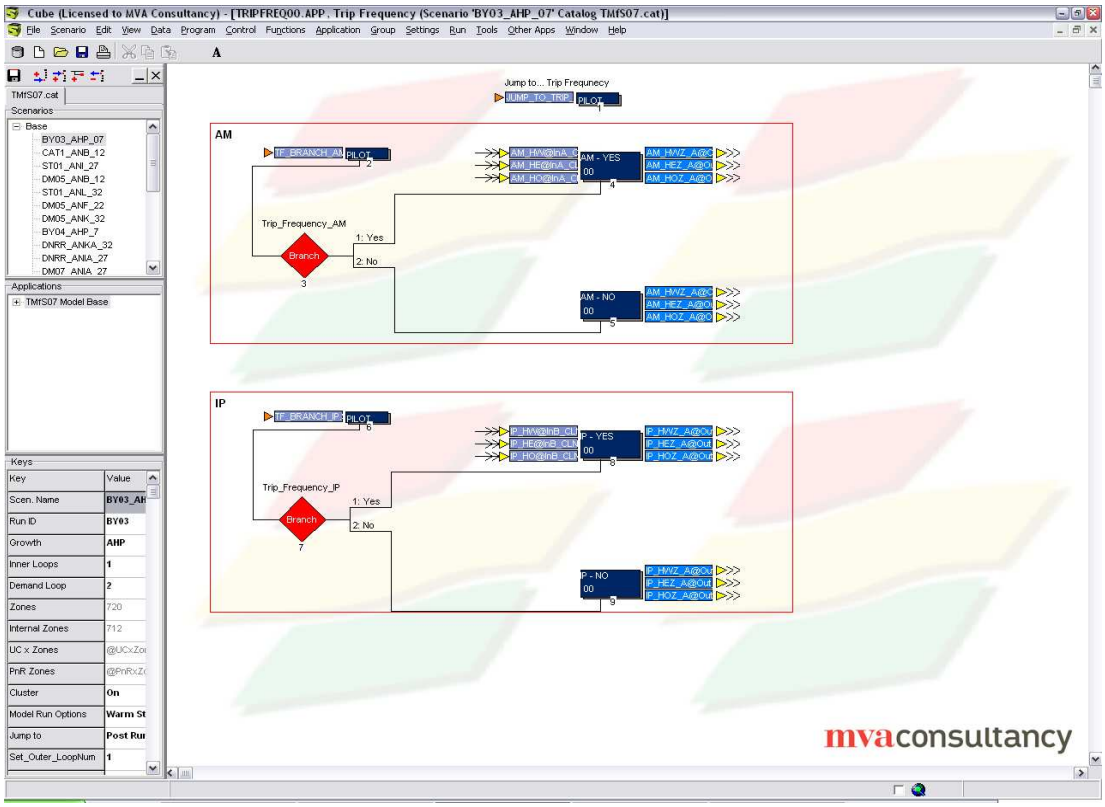

Figure 7.5 – Trip Frequency Branch Control

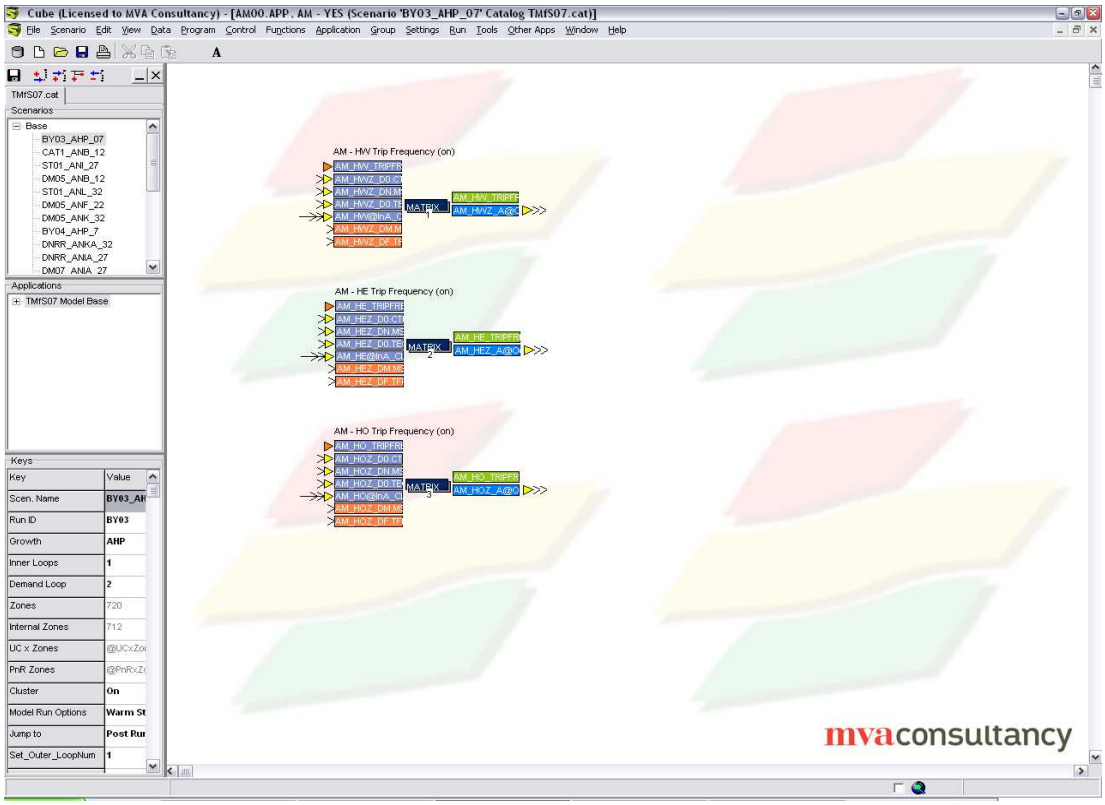
Cube (Licensed to MVA Consultancy) - [AM00.APP , AM - YES (Scenario 'BY03_AHP_07' Catalog TMfS07.cat)]
File Scenario Edit View Data Program Control Functions Application Group Settings Run Tools Other Apps Window Help
AM - HW Trip Frequency (on)
AM - HE Trip Frequency (on)
AM - HO Trip Frequency (on)
MATRIX
mvaconsultancy

Figure 7.6 – Trip Frequency Layout

7.7 Additional Module – Macro Time of Day

7.7.1 Macro Time of Day (MTOD) choice relates to changing the time period of travel in response to relative changes in the costs of travel between time periods.

Implementation

7.7.2 The implementation of MTOD has the following features:

- it has been implemented before main mode choice in the model choice hierarchy, which is consistent with guidance;
- the logsum composite costs are used in the MTOD choice process. The implication of this is that changes in relative road congestion between time periods will also influence time period choice. The reason for this is that average tolls by time period cannot be used alone for MTOD choice because it is possible that average toll paid per vehicle in the inter peak could be larger than that for the morning peak even though the basic toll rates are lower in the inter peak;
- the scaling parameter will need to lie between 0.0 and 1.0 and preferably close to 1.0 in order to be consistent with guidance. The value initially input into the model is 0.8, however, this may be refined when testing a live application;
- it has been included in the demand model as an optional feature. It is recommended that it is used only for model applications where there is the introduction of differential charging for road use between time periods, which is also consistent with the guidance;
- it is implemented for the morning peak and the inter peak periods only since it applies only to 'From-Home' trips, which are not modelled explicitly in the Evening Peak; and
- the process generates a pre-peak matrix for the morning peak. The pre-peak matrix creates 'To-Home' in the other time periods, using the Morning Peak reverse factors. The process is done by journey purpose and at the person trip stage. The model is applied separately for each row in the matrix.

7.7.3 The model is based on an incremental logit formulation. For the morning peak we have the model formulae:

P_{pre}, P_{peak}, P_{inter} are the base proportions in each time period. Note that we do not have P_{pre} so an estimate is made and it is set to 0.2; and

P'_{pre}, P'_{peak}, P'_{inter} are the forecast proportions in each time period.

Then the Macro Time of Day Choice is calculated as:

$$P'_{PEAK} = \frac{1}{(1 + A\exp(\beta(U_{IP} - U_{PEAK}) + B\exp(\beta(U_{PRE} - U_{PEAK}))}$$

$$P'_{INTER} = \frac{1}{(1 + A\exp(\beta(U_{PEAK} - U_{INTER}) + B\exp(\beta(U_{PRE} - U_{INTER}))}$$

$$P'_{PRE} = 1 - P_{INTER} - P_{PEAK}$$

$$where: A = P_{IP} / P_{PEAK}, B = P_{PRE} / P_{PEAK}$$

and:

P_i' are the new trip end productions for origin zone *i* by time period;

P_i are the original trip end productions for origin zone *i* by time period;

U_i are the composite logsum utilities for origin zone *i* by time period; and

β are the macro time of day choice parameters.

7.7.4 The base proportions of 'From-Home' trips in the Morning Peak and Inter-Peak were calculated from model data at the 'From-Home' trip end level, along with the assumption that P_{pre}=0.2.

7.7.5 Figures 7.7 and 7.8 show the Macro Time of Day layouts.

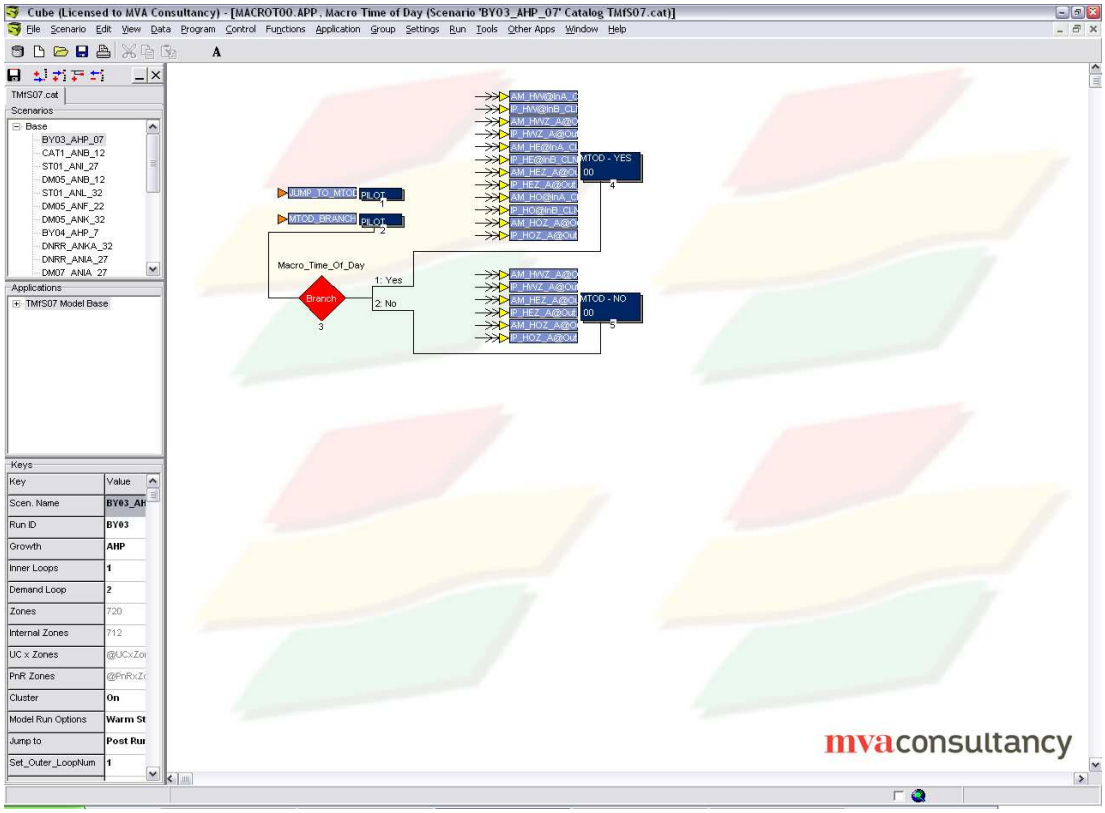

Figure 7.7 – Macro Time of Day Branch Control

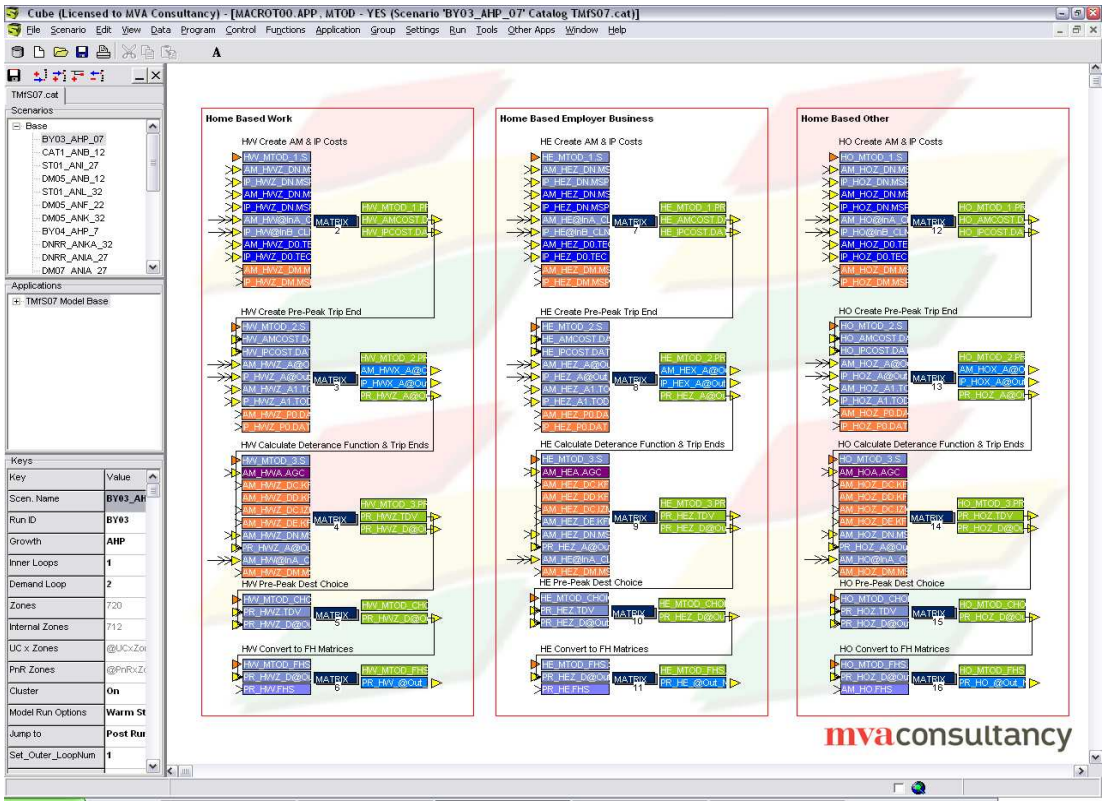

Figure 7.8 – Macro Time of Day Branch Layout

Appendix A – Cube Catalog Keys

Name of Key	Developer/ Applier	Type of Key	Allowed Values	Default Value	Relevant Section of Model	Description
Highway Link Types - Group 1	Developer	Edit Box	List of integers	10-13,18,19,31,32,33	Highway Assignment	Used to exclude selected link classes from assignments
Highway Link Types - Group 2	Developer	Edit Box	List of integers	9,28	Highway Assignment	Used to exclude selected link classes from assignments
Public Transport Period	Applier	Radio Button	All AM Only IP Only PM Only	All	Public Transport Assignment	If "Public Transport Assignment Only" is selected in the "Model Choice" key then this selects the time period(s) to run
Public Transport Matrix -AM	Applier	File Box	File Path and Name	{Catalog_Dir}\Runs\{Model Year}\{Run ID}\Output\{Growth}\PT\AM\PTAM_{Run ID}{Growth}{Model Year}{Demand Loop}.PTM	Public Transport Assignment	If running just a PT assignment this selects the AM matrix to use (if running a full model run this key value is not used)
Public Transport Matrix -IP	Applier	File Box	File Path and Name	{Catalog_Dir}\Runs\{Model Year}\{Run ID}\Output\{Growth}\PT\IP\PTIP_{Run ID}{Growth}{Model Year}{Demand Loop}.PTM	Public Transport Assignment	If running just a PT assignment this selects the IP matrix to use (if running a full model run this key value is not used)
Public Transport Matrix -PM	Applier	File Box	File Path and Name	{Catalog_Dir}\Runs\{Model Year}\{Run ID}\Output\{Growth}\PT\PM\PTPM_{Run ID}{Growth}{Model Year}{Demand Loop}.PTM	Public Transport Assignment	If running just a PT assignment this selects the PM matrix to use (if running a full model run this key value is not used)
Lines File - Intra Urban Bus	Applier	File Box	File Path and Name	{Catalog_DIR}\Runs\{Model Year}\{Run ID}\Input\Lines\Intra_Urban_Bus_{Run ID}{Model Year}.LIN	Public Transport Assignment	If running just a PT assignment this selects the Intra Urban Bus lines file to use (if running a full model run this key value is not used)
Lines File - Inter Urban Bus	Applier	File Box	File Path and Name	{Catalog_DIR}\Runs\{Model Year}\{Run ID}\Input\Lines\Inter_Urban_Bus_{Run ID}{Model Year}.LIN	Public Transport Assignment	If running just a PT assignment this selects the Inter Urban Bus lines file to use (if running a full model run this key value is not used)
Lines File - Rail	Applier	File Box	File Path and Name	{Catalog_DIR}\Runs\{Model Year}\{Run ID}\Input\Lines\Rail_{Run ID}{Model Year}.LIN	Public Transport Assignment	If running just a PT assignment this selects the Rail lines file to use (if running a full model run this key value is not used)
Lines File - Ferry	Applier	File Box	File Path and Name	{Catalog_DIR}\Runs\{Model Year}\{Run ID}\Input\Lines\Ferry_{Run ID}{Model Year}.LIN	Public Transport Assignment	If running just a PT assignment this selects the Ferry lines file to use (if running a full model run this key value is not used)
Lines File - Subway	Applier	File Box	File Path and Name	{Catalog_DIR}\Runs\{Model Year}\{Run ID}\Input\Lines\Subway_{Run ID}{Model Year}.LIN	Public Transport Assignment	If running just a PT assignment this selects the Subway lines file to use (if running a full model run this key value is not used)
Lines File - Tram	Applier	File Box	File Path and Name	{Catalog_Dir}\Runs\{Model Year}\{Run ID}\Input\Lines\Tram_{Run ID}{Model Year}.LIN	Public Transport Assignment	If running just a PT assignment this selects the Tram lines file to use (if running a full model run this key value is not used)
Run PT	Applier	Radio Button	All Loops First and Last Loops Only	First and Last Loops Only	Public Transport Assignment	Switch to select whether to run the PT model on every loop or on the first and last loop only, saving time.
Crowding	Developer	Radio Button	Yes No	Yes	Public Transport Assignment	Switch to turn on/off the crowding model
Crowding Iterations	Developer	Edit Box	Integer	5	Public Transport Assignment	Number of iterations in the crowding model
Bus_IVT_Factor		Edit Box	Real	1.2	Public Transport Assignment	In-Vehicle time weight for buses
Delete Route Files	Applier	Radio Button	Yes No	Yes	Public Transport Assignment	Option to delete PT route files - can be used for checking enumerated routes after assignment, but can be large
LAMBDAA	Developer	Edit Box	Real	0.2	Public Transport Assignment	Scaling factor for the Alternative Alighting model
LAMBDAW	Developer	Edit Box	Real	0.2	Public Transport Assignment	Scaling factor for the Walk Choice model
Sfactor	Developer	Edit Box	Real	1.25	Public Transport Assignment	Possible PT routes can be within 25% of the minimum cost route
Sconst	Developer	Edit Box	Real	5	Public Transport Assignment	Possible PT routes can be within 5 minutes of the minimum cost route
Choicecut	Developer	Edit Box	Real	0.05	Public Transport Assignment	Used to eliminate routes with low probabilities of use at Walk Choice or Alternative Alighting points
M1_Ubus_IVT_Fac	Developer	Edit Box	Real	1.2	Public Transport Assignment	In-Vehicle time weight for urban buses (mode 1)
M2_IUBus_IVT_Fac	Developer	Edit Box	Real	1.1	Public Transport Assignment	In-Vehicle time weight for inter-urban buses (mode 2)
M1_Re_Fare_Fac	Developer	Edit Box	Real	0.85	Public Transport Assignment	Urban Bus Fare Factor - used to reduce the cost of travel as a proxy for fares in Route Enumeration
M2_Re_Fare_Fac	Developer	Edit Box	Real	0.85	Public Transport Assignment	Inter Urban Bus Fare Factor - used to reduce the cost of travel as a proxy for fares in Route Enumeration
M3_Re_Fare_Fac	Developer	Edit Box	Real	1	Public Transport Assignment	Rail Fare Factor - used to reduce the cost of travel as a proxy for fares in Route Enumeration
Board_Penalty	Developer	Edit Box	Real	10	Public Transport Assignment	AM & PM Boarding Penalty
Wait Time Factor	Developer	Edit Box	Real	2	Public Transport Assignment	Factor applied to time spent waiting
Board_Penalty_IP	Developer	Edit Box	Real	5	Public Transport Assignment	IP Boarding Penalty
M1_Ubus_IVT_Fac_IP	Developer	Edit Box	Real	1.2	Public Transport Assignment	IP In-Vehicle time weight for urban buses (mode 1)
M2_IUBus_IVT_Fac_IP	Developer	Edit Box	Real	1	Public Transport Assignment	IP In-Vehicle time weight for inter-urban buses (mode 2)
Perform PnR Only?	Developer	Radio Button	Y N	N	P&R Model	
PnR Occupancy	Applier	Edit Box	Real	1.2	P&R Model	P&R Occupancy value - used for all purposes
PnR Lambda	Developer	Edit Box	Real	0.04	P&R Model	Sensitivity parameter for the logit curve in the P&R model
Max Change in PnR Attraction Factor	Applier	Edit Box	Real	1	P&R Model	Threshold value for convergence in P&R looping procedure for Attr
Max Change in PnR Site Demand	Applier	Edit Box	Real	1	P&R Model	Threshold value for convergence in P&R looping procedure for Demand
Max PnR Loop	Applier	Edit Box	Integer	20	P&R Model	Maximum number of P&R loops on any demand loop
PnR Penalty	Applier	Edit Box	Integer	30	P&R Model	Penalty incurred should far capacity be exceeded
PnR_Grad	Developer	Edit Box	Real	0.15	P&R Model	Gradient of attraction factor alteration
PnR_Succ	Developer	Edit Box	Integer	1	P&R Model	Number of successive converged loops required for P&R considered completely converged.
Number of Link Types	Developer	Edit Box	Integer	9	ACCDNT	Number of different links types in the network
Number of Local Authorities	Developer	Edit Box	Integer	30	ACCDNT, ENEVAL	Number of local authorities - used for outputting data by authority
Motorway DO factor	Developer	Edit Box	Real	7.6	ACCDNT	Damage Only Accident Rates for Motorway Links
Urban DO Factor	Developer	Edit Box	Real	17.7	ACCDNT	Damage Only Accident Rates for Urban Links
Rural DO factor	Developer	Edit Box	Real	7.8	ACCDNT	Damage Only Accident Rates for Rural Links
Zone Centroid Link Type	Developer	Edit Box	Integer	22	ACCDNT	Link Type for zone centroids - used to exclude links from the ACCDNT process
Exclude Local Authorities	Applier	Edit Box	List of integers	99	ENEVAL	List of local authorities to exclude from the ENEVAL process
Exclude Link Types	Applier	Edit Box	List of integers	22	ENEVAL	List of link types to exclude from the ENEVAL process
ENEVAL Annualisation Factor	Developer	Edit Box	Real	8760	ENEVAL	Annualisation figure used to calculate annual emissions totals
Emissions Per KM	Applier	Check Box	Checked/Unchecked	Unchecked (0)	ENEVAL	Emissions per km on links rather than total for the link
Emissions in KG (Default is Tonnes)	Applier	Check Box	Checked/Unchecked	Unchecked (0)	ENEVAL	Emissions in kilograms rather than tonnes
Delta_Number_of_Zones	Applier	Edit Box	Integer	6	ENEVAL	Number of Sectors in output DELTA file (if Define New Sectoring for ENEVAL = Yes)
DODELT_Flag	Developer	File Box	File Path and Name	C:\TMfS\TMfS07_V_2.0\Params\Test_DELTA_Flag.dbf	ENEVAL	Defines new sector for ENEVAL - currently in development
DODELT	Applier	File Box	File Path and Name	C:\TMfS\TMfS07_V_2.0\Params\Test_DELTA.dbf	ENEVAL	Create an output DELTA file
Define New Sectoring for ENEVAL	Applier	Radio Button	Yes No	No	ENEVAL	Is an output DELTA file required

Name of Key	Developer/ Applier	Type of Key	Allowed Values	Default Value	Relevant Section of Model	Description
Highway Link Types - Group 1	Developer	Edit Box	List of integers	10-13,18,19,31,32,33	Highway Assignment	Used to exclude selected link classes from assignments
Highway Link Types - Group 2	Developer	Edit Box	List of integers	9,28	Highway Assignment	Used to exclude selected link classes from assignments
Public Transport Period	Applier	Radio Button	All AM Only IP Only PM Only	All	Public Transport Assignment	If "Public Transport Assignment Only" is selected in the "Model Choice" key then this selects the time period(s) to run
Public Transport Matrix -AM	Applier	File Box	File Path and Name	{Catalog_Dir}\Runs\{Model Year}\{Run ID}\Output\{Growth}\PT\AM\PTAM_{Run ID}{Growth}{Model Year}{Demand Loop}.PTM	Public Transport Assignment	If running just a PT assignment this selects the AM matrix to use (if running a full model run this key value is not used)
Public Transport Matrix -IP	Applier	File Box	File Path and Name	{Catalog_Dir}\Runs\{Model Year}\{Run ID}\Output\{Growth}\PT\IP\PTIP_{Run ID}{Growth}{Model Year}{Demand Loop}.PTM	Public Transport Assignment	If running just a PT assignment this selects the IP matrix to use (if running a full model run this key value is not used)
Public Transport Matrix -PM	Applier	File Box	File Path and Name	{Catalog_Dir}\Runs\{Model Year}\{Run ID}\Output\{Growth}\PT\PM\PTPM_{Run ID}{Growth}{Model Year}{Demand Loop}.PTM	Public Transport Assignment	If running just a PT assignment this selects the PM matrix to use (if running a full model run this key value is not used)
Lines File - Intra Urban Bus	Applier	File Box	File Path and Name	{Catalog_DIR}\Runs\{Model Year}\{Run ID}\Input\Lines\Intra_Urban_Bus_{Run ID}{Model Year}.LIN	Public Transport Assignment	If running just a PT assignment this selects the Intra Urban Bus lines file to use (if running a full model run this key value is not used)
Lines File - Inter Urban Bus	Applier	File Box	File Path and Name	{Catalog_DIR}\Runs\{Model Year}\{Run ID}\Input\Lines\Inter_Urban_Bus_{Run ID}{Model Year}.LIN	Public Transport Assignment	If running just a PT assignment this selects the Inter Urban Bus lines file to use (if running a full model run this key value is not used)
Lines File - Rail	Applier	File Box	File Path and Name	{Catalog_DIR}\Runs\{Model Year}\{Run ID}\Input\Lines\Rail_{Run ID}{Model Year}.LIN	Public Transport Assignment	If running just a PT assignment this selects the Rail lines file to use (if running a full model run this key value is not used)
Lines File - Ferry	Applier	File Box	File Path and Name	{Catalog_DIR}\Runs\{Model Year}\{Run ID}\Input\Lines\Ferry_{Run ID}{Model Year}.LIN	Public Transport Assignment	If running just a PT assignment this selects the Ferry lines file to use (if running a full model run this key value is not used)
Lines File - Subway	Applier	File Box	File Path and Name	{Catalog_DIR}\Runs\{Model Year}\{Run ID}\Input\Lines\Subway_{Run ID}{Model Year}.LIN	Public Transport Assignment	If running just a PT assignment this selects the Subway lines file to use (if running a full model run this key value is not used)
Lines File - Tram	Applier	File Box	File Path and Name	{Catalog_Dir}\Runs\{Model Year}\{Run ID}\Input\Lines\Tram_{Run ID}{Model Year}.LIN	Public Transport Assignment	If running just a PT assignment this selects the Tram lines file to use (if running a full model run this key value is not used)
Run PT	Applier	Radio Button	All Loops First and Last Loops Only	First and Last Loops Only	Public Transport Assignment	Switch to select whether to run the PT model on every loop or on the first and last loop only, saving time.
Crowding	Developer	Radio Button	Yes No	Yes	Public Transport Assignment	Switch to turn on/off the crowding model
Crowding Iterations	Developer	Edit Box	Integer	5	Public Transport Assignment	Number of iterations in the crowding model
Bus_IVT_Factor		Edit Box	Real	1.2	Public Transport Assignment	In-Vehicle time weight for buses
Delete Route Files	Applier	Radio Button	Yes No	Yes	Public Transport Assignment	Option to delete PT route files - can be used for checking enumerated routes after assignment, but can be large
LAMBDAA	Developer	Edit Box	Real	0.2	Public Transport Assignment	Scaling factor for the Alternative Alighting model
LAMBDAW	Developer	Edit Box	Real	0.2	Public Transport Assignment	Scaling factor for the Walk Choice model
Sfactor	Developer	Edit Box	Real	1.25	Public Transport Assignment	Possible PT routes can be within 25% of the minimum cost route
Sconst	Developer	Edit Box	Real	5	Public Transport Assignment	Possible PT routes can be within 5 minutes of the minimum cost route
Choicecut	Developer	Edit Box	Real	0.05	Public Transport Assignment	Used to eliminate routes with low probabilities of use at Walk Choice or Alternative Alighting points
M1_Ubus_IVT_Fac	Developer	Edit Box	Real	1.2	Public Transport Assignment	In-Vehicle time weight for urban buses (mode 1)
M2_IUBus_IVT_Fac	Developer	Edit Box	Real	1.1	Public Transport Assignment	In-Vehicle time weight for inter-urban buses (mode 2)
M1_Re_Fare_Fac	Developer	Edit Box	Real	0.85	Public Transport Assignment	Urban Bus Fare Factor - used to reduce the cost of travel as a proxy for fares in Route Enumeration
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DODELT	Applier	File Box	File Path and Name	C:\TMfS\TMfS07_V_2.0\Params\Test_DELTA.dbf	ENEVAL	Create an output DELTA file
Define New Sectoring for ENEVAL	Applier	Radio Button	Yes No	No	ENEVAL	Is an output DELTA file required

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